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Vol. XXVI JANUARY to DECEMBER, 1921

JOURNAL

of the

WESTERN SOCIETY of ENGINEERS

PAPERS
DISCUSSIONS
ABSTRACTS
PROCEEDINGS

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The Rogers Press

CURRENT NEWS SECTION

JOURNAL OF THE
WESTERN SOCIETY of ENGINEERS

Volume XXVI | JANUARY, 1921 | Number 1

Rules of Robert W. Hunt Award—Report of Committee

Board of Direction,
Western Society of Engineers,
Chicago, Ill.

Gentlemen: The committee appointed to draft rules for the Robert W. Hunt Award submit the following:

Through the generosity of Robert W. Hunt, Past President of the Western Society of Engineers, there has been established a Trust Fund of five thousand dollars, the income from which is to be awarded for the best paper pertaining to the manufacture of iron or steel products or their subsequent fabrication, contributed during the calendar year by a member of the Western Society of Engineers, not more than thirty-five years of age. This award offers an incentive to the young engineer to undertake original work.

The Trust provides that the Trust shall terminate and the funds become the property of St. Luke's Hospital should there be no award during five consecutive years.

The Board of Direction shall appoint annually a committee on the Robert W. Hunt Award which shall consist of five men, at least three of whom shall be members of the Western Society of Engineers.

The Secretary of the Western Society of Engineers shall act as Secretary to the Committee of Award, without vote.

The duty of this Committee shall be to examine all papers received by the Western Society of Engineers from candidates for this award during each year ending December 31st, and report to the Board of Direction on or before January 10th of the following year which of these papers, if any, merit the award.

The findings of the Committee of Award shall be final. The prize shall be awarded by the Board of Direction. The Award shall be announced and presented at the Annual Meeting in June, and the notice shall be published in the July issue of the Journal of the Western Society of Engineers.

The prize shall consist of a cash payment approximating in amount the net annual income of the Robert W. Hunt five thousand dollar fund, with an engraved certificate signed by the President and Secretary of the Western Society of Engineers.

The rules of the Award shall be as follows:

A—The competition shall be restricted to members of the Western Society of Engineers not over thirty-five years of age.

B—The prize shall be awarded for the best paper, adjudged from the standpoints of originality of matter, applicability (practical and theoretical), valuable as a contribution to the manufacture of iron or steel products or their subsequent fabrication, logical development of contents, conclusiveness, completeness and conciseness.

C—Papers to be eligible for competition must be original and must have been produced by the author without collaboration with others, unless such collaborator or collaborators should be a member or members of the Western Society of Engineers—thirty-five years of age or under, and must not have been previously contributed to nor published by any other society or technical publication, in whole or in part. Presentation before a meeting of a section,

or publication by this Society during the year of the competition, shall not be considering as making a paper ineligible.

D—These rules may be modified by the Board of Direction without notice.

F. K. COPELAND, Chairman,
ROBERT W. HUNT,
THEODORE W. ROBINSON.

Dr. George E. Vincent Makes Excellent Talk at Noon-Day Luncheon

Dr. George E. Vincent, President, Rockefeller Foundation, will always be a most welcome speaker at our Noon-Day Luncheons. His talk at the Morrison Hotel, Saturday, December 11, on "Solving a Community Problem" was received enthusiastically by the 350 members and guests who were present.

In tracing the development of the community spirit, Dr. Vincent referred humorously to the various phases of "boosting." Emphasis was especially laid on community health. In illustration of what could be done in securing community health, Dr. Vincent referred to specific towns in which it was shown conclusively that the health could be improved considerably at a small expenditure. In one particular case, malaria and hook worm had practically been wiped out at a small cost.

Community health, according to the speaker, is really individual health as the individual judges his own condition by the conditions of those about him. The individual must be careful of his health and watch symptoms much the same as an automobile owner watches symptoms of disorder in his car. The individual should exercise regularly and if possible take part in athletic games in order that he may keep himself in good condition at all times. Good health is a positive force. In time, doctors will become disease preventers rather than disease curers.

Dr. Vincent also made a plea for the $33,000,000 relief fund being raised by Herbert Hoover for the children of Euope and called attention to the excellent work that has already been done by the Hoover Relief.

European Relief Council

The following editorial in the Chicago Evening Post is worthy of our consideration. It is a splendid tribute to Mr. Hoover. All of us are proud of the service he has given.

HOOVER'S GREAT APPEAL

Many are the great orations that have been delivered in Chicago, from the days of Lincoln and Douglas down thru the presidential conventions of more recent days. Few, we venture to say, have been more deeply moving than the plea made by Herbert Hoover at the Blackstone yesterday that America shall not abandon the 3,500,000 starving children in Europe whom she has been feeding since the war's close.

It was a great speech. It took from off the four big relief organizations the burden of responsibility for the work's continuance and placed it soberly, almost overwhelmingly, upon the shoulders of all of us. It did it without visible art, without rhetoric, without a trick of language, without a gesture, without the raising of the voice.

Of course, it was a great theme—great in the humanity of its subject, great in its perfect clarity of outline. But a lesser man might have spoiled it. The shoals of bathos, of sentimentality have been touched by other speakers on subjects as great.

Hoover stripped away every extraneous thing, every meretricious appeal. His very voice was drenched with pity, yet it was the pity of a strong man, conscious of the ability to act rather than fearful of the task before him. It was not so much a personal appeal as the posing of a public duty. "They are not any more my children than they are yours."

Fact followed fact, statesmanlike reason was heaped upon reason until the accumulated weight almost broke down the reserve which inhibited immediate individual reply.

In March, 1919, America was feeding 6,500,000 hungry children in Europe. She was doing it thru four powerful organizations, the American Relief, the Red Cross, the Jewish joint distribution committee and the Quakers. These organizations are now feeding 3,500,000 children thru 17,000 relief stations. These stations will have to be closed and the boys and girls abandoned to complete starvation unless financial help, amounting to $33,000,000, is forthcoming from America within sixty days.

This is the case. It seems to us that it is so primal that almost every other must yield to it. The four relief organizations have so conceived it. They themselves have been forced by indus-

trial depression to cease their by-activities, however fine and necessary these may be. They have come down to the one task of keeping alive these children. Like the allied armies after the German break-thru, they are "fighting with their backs to the wall;" like the allied armies again, they have come to one unified command. Under Herbert Hoover they have joined in creating the European Relief Council for the final struggle.

They must carry their work thru to the next harvest. For ten months they must feed the children who look to them and to them alone for life itself.

Many are the considerations of statesmanship that urge from America the generous response which she has made to every great appeal. "Can we, the richest nation in the world, abandon a band of children? We cannot thus sacrifice the respect of these millions of Europeans if we would maintain a civilization itself."

Again, as Mr. Hoover put it: "Peace is not made by documents; peace is made by the spirit of good will in the hearts of men . The American Service to Chlidren is the real ambassador of peace. If we send its ambassadors into a million and a half of central European homes this winter, we have established a protection against war more real than any battleship we can devise today."

Then, too, there are the staid, incontrovertible arguments against the world wisdom of letting the next generation in Europe grow up from an undernourished, bitter childhood into an undeveloped, embittered manhood. Will it, as Mr. Hoover asked, then stand on the side of an orderly civilization or against it?

In the close of the speech Mr. Hoover launched the idea that has been framed to give dramatic point to the nationwide appeal that opens next week. "We have," he said, "at the American board 3,500,000 guests. Will not every American family take one, at least, as an invisible guest at its Christmas table?"

We must give. In spite of drive weariness, business let-down or anything else, America must meet this appeal. She cannot abandon to starvation a band of helpless children.

Send in your checks to Charles G. Dawes, Treasurer, Central Trust Company, Chicago.

The Federated American Engineering Societies

At a meeting held in Washington, D. C., on Nov. 18-20, Mr. Herbert Hoover was elected President of this newly organized society.

The meeting was attended by seventy-five representatives and guests from seven National organizations and fourteen State, City or regional bodies. Mr. Hoover in accepting the Presidency outlined a line of activity which is very near his heart and which under his leadership can result in benefit to all concerned.

Mr. Hoover said, "We have just passed through a period of unparalleled speculation, extravagance and waste. We shall now not only reap its inevitable harvest of unemployment and readjustment but we shall feel the real effect of four years of world destruction and from it economic and social problems will stand out in vivid disputation. One of the greatest conflicts rumbling up in the distance is that between the employer on one side and organized labor on the other. We hear a great deal from extremists on one side about the domination of the employer and on the other about the domination of organized labor . Probably the tendency to domination exists among the extremists on both sides. One of the most perplexing difficulties in all discussion and action in these problems is to eliminate this same extremist. There are certain areas of conflict of interest, but there is between these groups a far greater area of common interest, and if we can find measures by which, through co-operation, the field of common interest could be organized then the area of conflict could be in the largest degree eliminated."

The other officers are as follows: Vice-Presidents, Calvert Townley, W. E. Rolf, Dexter B. Kimball and J. Parke Channing; Treasurer, L. W. Wallace. L. P. Alford was appointed temporary Secretary of the Executive Board.

There were a few changes in the Constitution and By-Laws proposed and adopted—probably more will be considered later after some experience with the organization has indicated the best policy.

July 21st, 1921, is the new time limit for Engineering Societies to join as Charter Members.

External Relations Committee, A. S. C. E.

The Board of Direction of the Am. Soc. C. E. at its meeting in November after the decided vote of the Society against joining the Federated American Engineering Society appointed a Committee on External Relations.

The Chairman of the Committee is R. C. Marshall, Jr., formerly in command of the construction division of the army. W. D. Gerber and C. H. Snyder, members of the Western Society of Engineers, are members of the Committee.

This Committee is to consider and make recommendations as to the relation of the Am. Soc. C. E. to other Societies—especially with reference to the F. A. E. S.

The personnel of the Committee is such as to warrant a safe hope that there can soon be promulgated a policy of co-operation which will redound to the credit of all concerned..

The report is to be reviewed by a Committee consisting of all the living Past Presidents before being submitted to the January meeting of the Board of Direction.

Mr. Onward Bates, Prof. Charles D. Marx, Prof. A. N. Talbot and Mr. John F. Wallace are Past Presidents Am. Soc. C. E. and members Western Society of Engineers.

YOUNG MEN'S FORUM

BENJAMIN SHAPIRO, Chairman.

The steady interest in the Saturday afternoon meetings of the Young Men's Forum was in evidence when Mr. Owen M. Fox, Western Manager, Business News Department, Engineering-News-Record, Chicago, addressed the Forum on "Economics and the Engineer."

He pointed out that engineers, the long accepted mentors of how to accomplish a certain purpose, what materials and arrangements of materials to use therein, and the order in which various activities should be undertaken in such accomplishment, are coming to be relied upon for advice as to when, for economic reasons, it is most advisable to proceed with work.

Their naturally sustained close contact with markets of both material and labor give them a wide vision of current conditions in those lines. Their analytically trained minds are peculiarly adapted to the logical weighting of all facts for the purpose of anticipating the economic future. A strictly mathematical mind is confined to the often erroneous conclusions to be drawn from cold figures, but the engineer, accustomed as he is to estimating variables, should be more apt to make allowance for extraneous influences.

The young engineer who widens his field of personal knowledge to include at least a cursory understanding of the principals of economics will greatly enhance his value to his clients. He will be able to avoid the serious errors of judgment often made by practitioners in their mature years when they arrive at the position of valuation engineers or become associated in an executive capacity with some great industrial enterprise.

The next meeting of the Young Men's Forum will be held Saturday afternoon, Jan. 8, at 1:30 p. m. in the Society rooms. Mr. Samuel H. Moore, Director of Welfare and Pensions, Peoples Light & Coke Co., will discuss "The Engineer from the Human Standpoint."

On Jan. 22, Mr. Harwood Frost will discuss "Engineering Literature." Both of these are prominent topics of the day, and there is room for some additional attendance. Mark these dates in your calendar and bring some one with you. Those in charge of the meetings will see that everyone gets acquainted.

INCREASE OF MEMBERSHIP COMMITTEE

C. W. PENDELL, Chairman.

No particular effort has been made since our Big Drive of a year ago to secure New Members. The Drive brought in so many members that it has taken considerable time to assimilate them into our organization and increase our activities so as to include the enlarged membership.

The time has now arrived, however, when we should bestir ourselves and get new timber into our structure, both for the strengthening of the structure and the upbuilding thereof.

We have a firm foundation and the superstructure looms up conspicuously on the sky line formed by the engineering societies of the country, but we lack that overtopping majesty that would be ours if we added to our membership those eligible engineers in which our City and its environs abound.

We need the increased membership for financial reasons. Our increased activities have increased our expenses. Up one—up the other. But we can stand the increased expense if we are getting the worth of our money. Each new member means just that much more potential power. Each present member benefits from each such incerment.

Any engineer can be a salesman if he believes in the object he is selling. The Society needs volunteer salesmen—you believe membership in the Society worth while—get out and sell it to one or more new members.

NOON DAY LUNCHEON

J. H. LIBBERTON, Chairman.

As a result of active work by an auxiliary committee appointed to assist in the work of the Noon-Day Luncheon Committee, 350 members and guests attended the Noon-Day Luncheon on Saturday, December 11.

Dr. Geo. E. Vincent, President Rockefeller Foundation spoke on "Solving a Community Problem" and not only gave some very interesting examples of what could be done in increasing community health, but also entertained the audience by his humorous allusions to engineers and communities. Dr. Vincent lived up to his reputation as one of the foremost platform speakers in the country today.

Announcement was made of the next Noon-Day Luncheon meeting to be held Friday noon, January 14, 1921, in the Cameo Room, Hotel Morrison. Thomas R. Preece, first vice-president of the Bricklayers', Plasterers' and Stone Masons' International Union of America, will speak on "What Labor Expects of the Engineer."

Those who have had the opportunity of hearing Mr. Preece state that he has a very modern conception of the place of labor in industry and that he is an excellent speaker. As. Mr. Preece has given considerable study to jurisdictional disputes, it is very possible that he will discuss this phase of the labor question at our Noon-Day Luncheon.

INDEX VOL. XXV.

The Index to the Journal of the Western Society of Engineers for the year 1920 has been published and can be obtained upon application to the Editor.

Notes on Speakers

Mr. A. S. B. Little is Gas Engineer of the Public Utilities Commission. He has had a broad experience both in England and in this country in management, design, construction and operation of gas plants. He has been Gas Engineer of the Commission during all of the important rate hearings resulting from increased cost during and since the war, and is eminently fitted to give an unbiased discussion on the subject on which he is to talk.

His paper on "Public Utility Rates" will be presented Jan. 12th.

John Foley, Forester of the Pennsylvania System, who will adrdess the society on the evening of Jan. 14th, on the subject of "Tie Supply of the Future" is one of the leading students of the preservation of timber for railroad use. During the period of government control he was associate manager of the Forest Products Section, Division of Purchases, United States Railroad Administration, which capacity he was responsible for the purchase and treatment of all ties used by the railroads under federal control. While in this position he issued the well known standard specifications for the preservative treatment of ties. As forester of the Pennsylvania, Mr. Foley has had extended experience in the use and treatment of railroad cross ties and has also been in charge of the reforestation work carried on by the Pennsylvania lines east of Pittsburgh.

Since the reorganization of the Pennsylvania early in the past year, his authority has been extended over the entire system. He is also a past president of the American Wood-Preservers' Association. We are especially fortunate in obtaining Mr. Foley's services at this particular meeting since it will enable us to obtain the co-operation of a considerable number of railway officers and those engaged in timber preservation who will be gathered in Chicago at that time on the outset of a trip to the Pacific coast to attend the seventeenth annual convention of the American Wood-Preservers' Association.

J. O. Carr is the Chief Engineer of the Morkrum Co., of Chicago.

Printing Telegraphy is a new development and is now in so successful operation that about six messages out of every ten handled by the Western Union Telegraph Co. are transmitted and received automatically.

Mr. Carr will be the speaker Jan-6th.

Professor Horace Secrist will be the speaker at the General Meeting of the Society to be held Monday, January 3rd. Mr. Secrist is Professor of Economics and Statistics, and Director, Bureau of Business Research, Northwestern University School of Commerce.

The subject of the evening is "The Relation of Statistics to Professional Work in Industry."

Prof. Secrist has had a very large experience which enables him to speak with authority on this subject. In 1909 he was expert special agent of the United States Census Bureau; 1910 and 1911 with the Wisconsin Tax Commission, and 1911 and 1912 with the Wisconsin Industrial Commission. Since 1914 he has served as expert special representative on the United States Commission on Industrial Relations; United States Shipping Board; and in 1918 was special representative of the United States Shipping Board, American Section of the Allied Maritime Transportation Council in London. Prof. Secrist's new book on "Business Statistics—Their Charting and Analysis" will soon be published.

P. S. Combs, City Engineer of Chicago, will speak at the meeting of the Society held January 17th. The problem of maintaining an ample water supply for the City of Chicago calls for a very large experience in organization work. Mr. Combs has had great success in maintaining the high efficiency of the engineering department of the City of Chicago.

His subject is—"Chicago City Waterworks, Past, Present and Future," and is important.

Every engineer in Chicago can render service to his municipality by being informed with regard to municipal operations involving a large amount of engineering. Mr. Coombs is well qualified to explain this fully to our membership.

"Reducing the Cost of Steel Frame Buildings," will be the subject of Mr. R. Fleming's paper to be presented January 10th. Mr. Fleming has been engineer for the American Bridge Company in New York City for twenty years, and during that time has had a very wide experience in the design, detailing and fabrication of steel structures.

As a student of the economics of steel building construction, Mr. Fleming has been an extensive contributor to engineering publications.

J. J. REYNOLDS

James J. Reynolds was born in Cincinnati, Ohio, in 1850 and came to Chicago in 1885.

Mr. Reynolds was well known in railroad circles and in other construction work, having served as engineer for the New York Central in building the Chicago, Indiana & Southern R. R. Later he served on a Commission with Messrs. John Ericson, then city engineer, City of Chicago, and E. C. Shankland in the design and construction of the Chicago municipal pier.

Mr. Reynolds died Nov. 28th in Chicago and was at the time of his death Consulting Engineer for the Elgin, Joliet & Eastern R. R.

He became a member of the Western Society of Engineers in 1890.

Practical Training Course in Boxing and Crating

Given at Forest Products Laboratory, Madison, Wisconsin.

THE DEMAND FOR BETTER PACKING

There is a daily loss to shippers and manufacturers conservatively estimated at $500,000 due to poor packing and expensive and improperly designed containers for all classes of domestic and foreign shipments. Class 1 railroads alone expended for lost and damaged freight during the year 1919, $103,078,862, and the western inspection bureau in 12 cities during July, 1919, refused or repaired 43,738 packages. These are but two isolated examples.

An efficient container must deliver its contents in a satisfactory condition at a minimum cost.

HOW THE DEMAND FOR ACCURATE INFORMATION IS BEING MET

Commercial research and mechanical tests at the Forest Products Laboratory on better containers began in 1915 in co-operation with the National Association of Box Manufacturers, and the National Canners and National Wholesale

Grocers Associations. In this work methods and testing equipment which have become standard for the box industry were developed.

The War Department prepared general specifications for overseas shipments from the data accumulated by the laboratory . Packing studies were afterwards made at ports and economical designs worked out for many containers for war equipment.

The Laboratory has co-operated with associations and companies in improving the packing of widely varying types of commodities such as electric lamps, cream separators, automobile parts, small tractors, talking machines, boiler castings, furniture, paints and oils, piano benches, fruit baskets and crates, and shoes. These tests and studies, in many cases, resulted in the redesign of the container. The new design gave increased strength and often decreased the amount of material used in its manufacture; gave security against pilfering; decreased the cubic contents; reduced the labor and cost of manufacture; made possible more rapid production of packages; decreased cost of ccean freight; and permitted improved methods of handling freight. This work is of value to all manufacturers, shippers and dealers, and to the public at large, which is vitally concerned in receiving its necessary commodities in satisfactory and economical containers.

The demand upon the laboratory for information suggested a series of co-operative training classes for men from various industries. These classes began during the war and have been attended by representatives of such concerns as: Western Electric Company, Montgomery Ward & Company, Armour, Swift, Morris and Sprague-Warner packing companies, Quaker Oats, General Motors, forwarding companies, and furniture and box manufacturers.

The course lasts 5½ working days. Reference material and condensed notes are given out and it is necessary for those attending to devote a portion of each evening to study.

Only a limited number are accepted in a class. This makes possible the exchange of ideas and experiences with men from different organizations and the research men of the laboratory. A series of lectures on kiln drying, glues, fibre board, and box wood is given. One subject is studied each day.

OUTLINE OF BOXING AND CRATING COURSE

The object of this course is to demonstrate for manufacturers and packers the principles that underlie proper box and crate construction and develop economical containers that will deliver the contents to its destination in a satisfactory condition at a minimum cost.

Monday — Registration —"What did you come to get?" Tour of Forest Products Laboratory.

Drop tests to demonstrate characteristic failures of different types of boxes.

Tuesday—Drum tests to demonstrate the necessity of adequate nailing. Demonstration to show effect of varying number of pieces on sides and ends.

Wednesday—Relative holding power of different kinds of nails. Effect of using green lumber for boxes. Tension tests.

Thursday — Strapping; methods of application and efficiency. Influence of grade of lumber and location of defects on boxes and crates. Crate construction and tests. Drum tests.

Friday—Solid and corrugated fiber board and wirebound boxes and crates. Identification of boxwoods.

Saturday—Source of supply and characteristics of box woods. Final questionnaire—"Did you get what you came for?" Final conferences.

The course is given in the most completely equipped box laboratory in the country. For a long time this box testing laboratory was the only one in the world, but within the last year the laboratory has aided in planning several commercial laboratories.

THE FOREST PRODUCTS INDUSTRIAL RESEARCH LABORATORY

The Forest Products Laboratory is the industrial research branch of the Forest Service of the United States Department of Agriculture at Madison, Wisconsin, which is maintained in co-operation with the University of Wisconsin. The guiding thought in the development of the Forest Products Laboratory has been the systematic acquiring of useful knowledge that may be transformed into the power that builds up American industry. To this end the laboratory is engaged in:

(1) acquiring fundamental knowledge about wood and its properties.

(2) applying this knowledge to practical uses of wood, and

(3) seeing to it that economical methods and materials developed are utilized to the best advantage.

In this work 220 engineers, wood technologists, manufacturing specialists and assistants are employed.

Investigations and experiments are undertaken both independently and for associations and companies on a co-operative basis. Results obtained are disseminated through co-operative reports, commercial demonstration, correspondence, government bulletins, mimeographed circulars, articles in the trade press, and practical instruction courses in Boxing and Crating and Kiln Drying given at the laboratory.

The Boxing and Crating Course will be given as long as there is a demand for it. A co-operative fee of $100 payable to the Forest Products Laboratory, is charged to partially cover the cost of conducting the course. This fee does not include traveling and living expenses. Rooms in Madison may be obtained at from 50 cents to $3.00 a day; board can be obtained as low as $5.50 a week. A list of hotels giving rates and location will be sent each man enrolled.

Dates for the next three courses are:

January 10-15, 1921; March 7-12, 1921; May 2-7, 1921.

All correspondence should be directed to the Director, Forest Products Laboratory, Madison, Wisconsin.

Uniform Registration Law

At a meeting of Engineering Council held in Chicago, Oct. 21, 1920, there was adopted a revised form of the proposed Uniform Registration Law for Architects, Engineers and Surveyors, submitted by the Committee on Licensing of Engineers, T. L. Condron, M. W. S. E., Chairman.

The modifications of the proposed law agreed upon in consultation with the chairman of the Joint Committee are briefly as follows:

1.—Transposing into alphabetical order the terms architect, engineer and land surveyor.

2.—Omitting the adjective "professional" before "engineer" and "engineering."

3.—Providing that persons practicing these professions at the time this law goes into effect may continue so to practice without registration.

4.—Extending the time that a non-resident may practice in a state without registration from 15 to 30 days.

5.—Providing that a non-resident may practice without registration from 15 to 30 days.

5.—Providing that a non-resident may practice without registration as a consulting associate of a resident registered architect, engineer or land surveyor.

The full text of the proposed law was printed in the Journal of the Western Society of Engineers, Vol. XXV., No. 14 —Oct, 1920, under the title, "Uniform Laws for Registering Engineers, Architects and Surveyors Recommended by Special Committee Engineering Council.

Many of our readers will be pleased to know that Engineering Council has published in pamphlet form the recommended, Uniform Law above mentioned and includes abstracts of State Registration Laws. Copies of this pamphlet may be had by addressing the Secretary, Engineering Council, 29 West 39th Street, New York City.

National Department of Public Works

The coming session of congress will undoubtedly give considerable attention to the proposed department of public works. This matter has been before congress for some time in the form of the Jones-Reeves Bill.

Recently Senator McCormick has announced that he will introduce in congress a bill supporting both a department of public works and a department of public welfare. These departments are separate from each other. It is apparent, however, that attention is being directed to the importance of the department of public works in which engineers are vitally interested.

The Chicago Tribune of November 29th contained the following editorial:

AN ERROR IN WATERWAY CONTROL

"The annual report of the chief of engineers of the army asks for $130,000 for work on the Illinois river in the next fiscal year. The sum is sought, according to Gen. Beach, because 'more extensive dredging operations are imperative, both for maintenance and completion of the Illinois waterway project.' The general appears to believe it is a great sum which will accomplish a great work.

"It appears to the layman who has made some study of the Illinois waterway project that better evidence of the error of leaving such matters under control of the army engineers could hardly be found. Even in the war, when army engineers might reasonably be expected to be at the height of their efficiency, they were forced to rely upon civilians for many of their important works. Why should civil projects and progress wait upon them in time of peace? The utter inadequacy of the sum asked for the work needed is sufficient evidence that we must wait.

"There appears no good reason why such public works should rest with the army. They are essentially projects of peace. There appears to be no more reason why they should be under army control in peace times than that railroads or automobile roads should be under army control. The error of the present system is constantly demonstrated.

"Let the army engineers do army work, and perfect themselves in it against the next war. What we want is practical, operating waterways and harbor facilities, not an experimental station or training school."

It is necessary that engineers intelligently support the proposed department of public works if it is to be realized in the near future.

Reply to Book Review by H. L. Brown

To the Editors:—

The issue of the Journal of the Western Society of Engineers for December contained a review of the book, "Radio Engineering Principles," of which the writer is co-author, by Mr. Montford Morrison. In his review Mr. Morrison made the criticism that the book "has the unfailing characteristic common to a great many books" of containing subject matter "so much more adequately treated elsewhere." In this he referred particularly to the first two chapters on the "Underlying Electrical Theory" and on the "Properties of Oscillatory Circuits." His criticism is believed to be not very well taken and it would seem to indicate that he has made the mistake common to many book reviewers of failing to read the preface to learn the scope and purpose of the work the authors have undertaken. Had he read the preface in "Radio Engineering Principles" it is felt that this first paragraph quoted therefrom perhaps would have answered his comment before it was written and indeed have led to a more worthy criticism of how well the book measured up to the purpose ascribed to it.

"This book is written in an effort to meet the need and great demand for a general textbook on radio, covering the new and extensive developments in the art made during the war. It is therefore devoted very largely to the study of the characteristics and use of the three-electrode vacuum tube in radio telegraphy and radio telephony, since it is around this device that the present and future of the science seem to center. But to meet the requirements of a general textbook, the principles involved in the older radio apparatus are also treated with sufficient fullness to inform the student on all essential principles of wireless communication."

As a general textbook, then, it would hardly be logical to omit the fundamental electrical theory as related primarily to the treatise on radio to follow, including the properties of oscillatory circuits, and expect the student to purchase one or two other books to get the necessary preliminary knowledge for the course in hand. Furthermore, the manner of treating the underlying theory in the first chapter is quite different from that employed by any other author and it was so formulated because it is believed that it makes easier the grasp of the intricate theory of three-electrode vacuum tube to which more than half the book is devoted. Also, it is a fact that this underlying theory and the properties of oscillatory circuits are treated less fully then in many other books, and designedly so, for the authors had a good deal of experience during the war in training men in a working understanding of radio and doing it in a hurry. Thus this book is intended to give the student a good working knowledge of the science of radio communication, and if he then chooses to become an expert in the theory behind it, it is expected that he will naturally pursue his study in other more detailed, more exhaustive and unquestionably more able treatises on the underlying theories involved.

HARRY L. BROWN.

New Advertisers

The Journal of the Western Society of Engineers wishes to call attention to the new advertisers in this issue:

Allen F. Owen, Onward Bates, Bazner Press, Premier Reporting Co., and Thos. J. Dolan.

LIBRARY SERVICE

MISS ELTA VIRGINIA SAVAGE, Librarian

The Librarian wishes to call to the attention of the membership the book reviews which are appearing in the Librar Service column. These reviews, written by engineers who are specialists in the particular line of engineering covered by the book, should be of interest to you. They present concise, clear summaries of current technical literature.

Through the courtesy of S. E. Thompson, the Library has received a copy of the third edition of "A Treatise on Concrete, Plain and Reinforced," by F. W. Taylor and S. E. Thompson.

Paul C. Tris, Welding Engineer with the Metallurgical Research Engineering Company, presented the Library with Granjon and Rosemberg's "Practical Manual of Autogenous Welding," and Dunham's "Automobile Welding with the Oxy-acetylene Flame."

J. R. Cravath added the following volumes to the Library: Electrical Engineer, volumes 17-21; Electrical World, volumes 17-27; Street Railway Review, volumes 3-5; Public Utilities Reports Annotated, 1915-1918.

The American Gas Association has signified a willingness to co-operate with the Western Society by completing the file of Proceedings and placing the Library on the mailing list to receive American Gas Association Monthly and Bulletin of Abstracts.

The following annual proceedings have recently been received: American Wood-Preservers' Association, Proceedings, 1920; American Railway Engineering Association, Proceedings, 1920; American Institute of Electrical Engineers, Transactions, 1919; Institution of Civil Engineers, Minutes of Proceedings, 1917-18. National Advisory Committee for Aeronautics, Annual report, 1919; North-east Coast Institution of Engineers and Shipbuilders, Transactions, 1919-20.

The Library Committee is anxious to enlarge the usefulness of the Library during the year 1921.

In order to do this, a closer acquaintance with the needs of each individual member will be necessary. Please register your personal interests with the Committee early in the year. We wish to render service to every member of the Western Society who has need for it.

Book Review

Railroad Curves and Earthwork with Tables, by C. Frank Allen, S. B., M. Am. Soc. C .E., Professor of Railroad Engineering in the Massachusetts Institute of Technology. Sixth edition, revised. New York and London: McGraw-Hill Book Company, Inc. Flexible Leather; 5x7 inches; 289 pages; illustrated, $4.00.

No cursory attempt to review a standard work of this kind, now in its sixth edition, can do it justice. There can be no question that the book as a whole has proved its worth through over thirty years use by the engineering profession.

The description of railroad surveying methods is complete and accords with standard practice. The author does not enlarge on this subject more than is absolutely necessary for a proper understanding of the problems which are explained later in the text. More might be added on the problems of the present day, peculiar to maintenance of way work, since the proportion of such work as against actual location and construction is very large. The use of the plane table for reconnaissance and preliminary surveys should be gone into more fully as this most efficient instrument is gradually coming into its own. In the future a large amount of relocation work will be done, and for this work maps showing breadth of country rather than length will be needed. For this type of mapping, in open country, nothing can equal, in speed and accuracy, the plane table stadia method.

It is unfortunate that the author uses the term "turning point' 'instead of the more distinctive "hub" or "transit point" in his description of transit survey methods. This use might confuse a beginner.

The author develops the use of simple and compound curve work in a very clear and exact manner. Little more could be desired in this section, as nearly all the difficult problems of field work are fully covered. Considerable time can be lost trying to solve such problems in the field. This has led some engineers to carry more than one text, in order to find the needed solution quickly. Under reversed curves, the inclusion of a solution for laying out a piece of tangent between two reverse curves connecting parallel tangents would be advisable. This is to take care of run-off super-elevation.

The section on turnouts could be improved if the author would go even farther, and use throughout the now general practice of allowing for straight frog and switch rails. Too much space is devoted to the switch proper; almost all railroads now have standard dimensions for the turnout and the actual work of laying it out falls to the track foreman. The discussion of stub switches is superfluous and could be eliminated with very little loss to the average user of the book. It is questionable whether any stub switch layouts now made, require a theoretical determination. Turnouts to and from sidings on curved and straight track and the various problems of crossing frogs are well taken care of and could hardly be improved.

The adaptation of the Cubical Spiral for laying out easement curves is explained and sufficient theory given to indicate the development of its various functions. For ease in field work the author advises the use of the A. R. E. A. Spiral and has included the necessary tables in the back of the book. This A. R. E. A. or Ten Chord Spiral is fully explained and its use should be possible to anyone accustomed to the deflection method of laying out such curves.

Under Earthwork the author has included in this edition the co-ordinate distance method of figuring areas of cross-sections terming it a "rule of thumb" method which has had considerable use in the Railroad Valuation work conducted by the Interstate Commerce Commission. This little known method is both rapid and mathematically exact. The Interstate Commerce Commission has received most of the credit for its use but as it is given in "Methods for Earthwork Computation," by C. W. Crockett, 1st edition, 1908, John Wiley & Sons, it is not at all new. A detailed description is also given in the Engineering News Record, July 22, 1920, page 152, by Mr. J. A. MacDonald. The secton on mass diagrams is essentially the same as in former editions. (This is practically the only handbook which completely describes such curves.) It might have been advisable to include a description of the use and properties of the area diagram developed in connection with the Valuation work on railroads. The latter has the advantage over the usual mass curve of permitting cut and fill in sidehill sections to be separately measured. This is possible by plotting areas as ordinates above the line for cut and below the line for fill. The area of the diagram enclosed by a broken line through these ordinates and the base line is the volume of cut or fill. Quantities are usually taken off with a planimeter.

The tables and diagrams are unusually complete. Personally the writer would prefer the functions of a 1° curve grouped in one table as is usually done, instead of separate tables for each function. A table of the various natural and log functions of frog angles would be of great assistance for the solution of turnout problems.

It is to be regretted that the author has not stepped out of the strict field of the title of his book and given one chapter devoted to fieldwork on the other branches besides curves and earth work. The laying out of retaining walls, culverts, abutments, piers, pedestals, trestle bents, etc., in bridge work; ballast stakes for ballasting, curb and roadway stakes for paved streets and highways; batter boards for buildings, sewer and water pipe grade stakes, etc., is not fully covered by any of the present field-books. For the young engineer this is most important information and something seldom fully covered in his school work.

S. R. TRUESDELL.

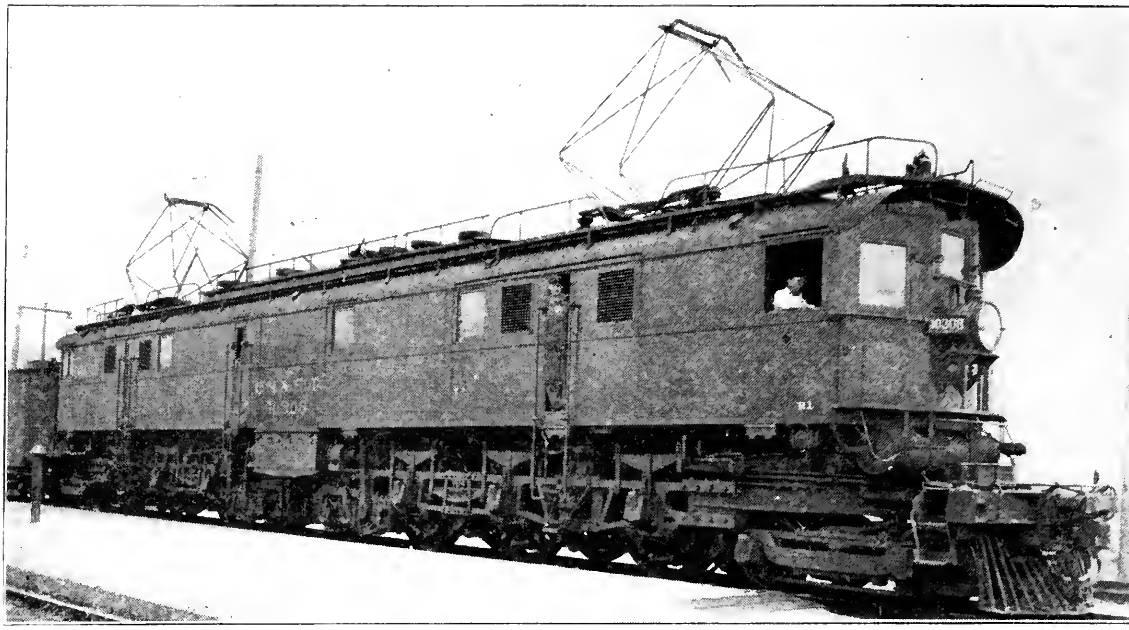
Mr. Hoover Guest of the General Committee of Technical Societies of Chicago

About eighty-five representatives of the Member societies met at dinner, Friday, Dec. 10th, at the Chicago Engineers Club. Mr. W. L. Abbott, vice-chairman, presided and introduced Mr. Hoover as the President of the Federated American Engineering Societies.

It was a clear statement of a plan of mobilizing the Engineers of the country as a service to our nation. The leadership of Mr. Hoover is one we all have confidence in. The Federation with Mr. Hoover at its head and subject to sane modification in its organization as explained in the notable address is quite different from the inflexible plan of the Jont Conference Commttee.

Mr. Hoover was given an enthusiastic reception. He has broad knowledge of the conditions and a splendid ability to inspire others.

We will be glad to know what modifications he will propose in order to perfect this organization.



New Electric Passenger Locomotives in Operation on the C. M. & St. P. Railway*

W. H. MUNN, Railway Dept.,
Westinghouse Electric & Mfg. Co.

The Chicago, Milwaukee & St. Paul Railway has now in electric operation 651 miles of main line track, 440 miles between Harlowton, Montana, and Avery, Idaho, and also 211 miles between Othello and Seattle, Washington.

On the 440 mile run, three mountain ranges, the Belts, the Rockies and the Bitter Roots are crossed. The grades encountered between Harlowton and Avery vary from 0.7 percent to 2.0 percent, the most difficult being the 21 mile 2.0 percent, between Piedmont and Donald on the eastern slope of the Rockies.

Under steam operation the 440 miles stretch between Harlowton and Avery comprised two divisions, the Rocky Mountain Division, extending from Harlowton to Deer Lodge and the Missoula Division, extending from Deer Lodge to Avery. Each of these divisions had an engine terminal at a midpoint as well as at each end, thus permitting a change of steam motive power after each run of 110 miles.

Under electrical operation the mid-division points at Three Forks and Alberton were eliminated, and the electric locomotives were changed only at Deer Lodge, a run of approximately 220 miles. To the layman this may seem quite a performance, but during the past year even this has been surpassed in that the present passenger locomotives have eliminated the change over at Deer Lodge. The new electric locomotives now run the whole distance of 440 miles, and during the stop at Deer Lodge the engine and train crews only are changed. The locomotives are taken off at Deer Lodge for shop inspection after mileage varying from 3,000 to 5,000, which means an inspection every eight or ten trips.

*Editor's Note: One of these locomotives was recently exhibited in Chicago and in response to inquiries by many of our members, we are pleased to publish this article through the courtesy of the Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

The following is the daily mileage report for locomotive No. 10305, during the month of September, 1920; which is typical of the performance of the Westinghouse locomotives on this electrification:

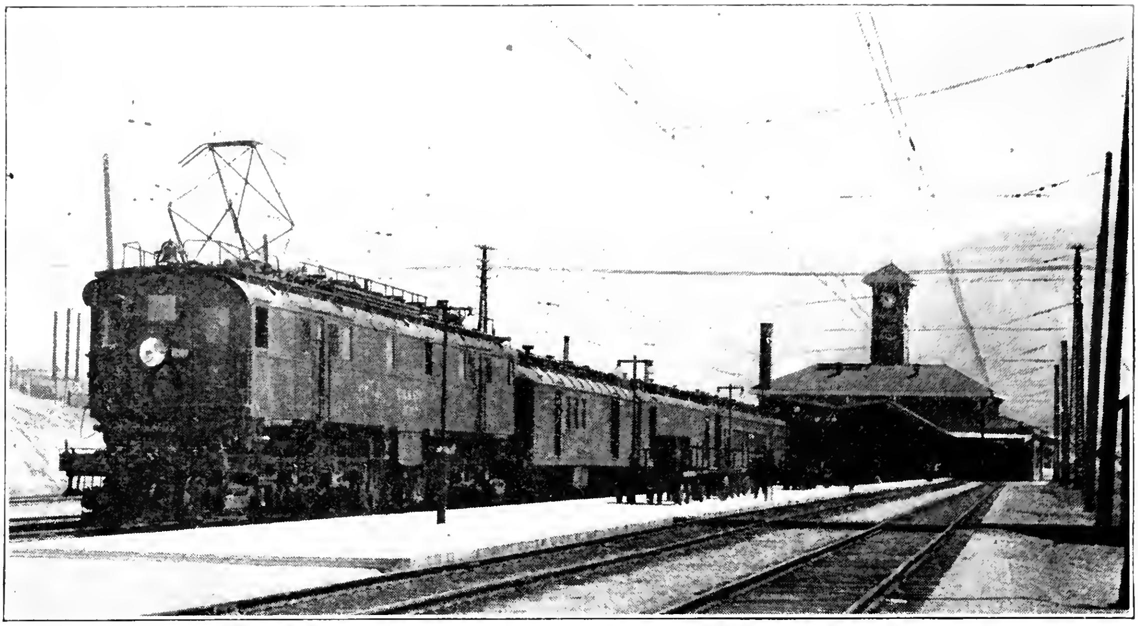
September 2	62 miles
September 4	226 miles
September 5	440 miles
September 6	438 miles
September 7	440 miles
September 8	438 miles
September 9	440 miles
September 11	438 miles
September 12	440 miles
September 13	425 miles
September 14	438 miles
September 15	440 miles
September 17	438 miles
September 18	453 miles
September 19	416 miles
September 20	414 miles
September 21	440 miles
September 22	438 miles
September 23	440 miles
September 24	438 miles
September 25	440 miles
September 26	438 miles
September 27	440 miles
September 28	438 miles
September 29	440 miles
September 30	438 miles
Total	10,776 miles

These passenger locomotives running between Harlowton and Avery were built by the Westinghouse Electric & Manufacturing Company at East Pittsburgh, Pa., and put into regular service almost a year ago.

A detailed description of the locomtive apparatus or performance is beyond the scope of this article, but a more general description will be given.

The locomotive which weighs 275 tons is equipped with six, twin armature direct current motors and six driving axles. Each twin motor armature shaft has a 24 tooth pinion meshing into a common 89 tooth gear. This gear is pressed on a quill, which is practically a hollow casting surrounding the driving axle. Movement between the quill and wheel is obtained by what are known as quill springs, there being seven on each wheel. This arrangement provides a high center of gravity locomotive with a flexible drive. Each armature is wound for 750 volts and the twin armatures are connected permanently in series giving 1,500 volts per motor. The motors are insulated for operating two in series on the 3,000 volt trolley line.

The locomotive has a continuous rating of 3,400 H. P. and a one hour rating of 4,200 H. P. with a maximum rated speed of 65 m. p. h.



In starting from a standstill all motors (12 armatures) are placed—through grid resistances—in series across the 3,000 volts. To increase the speed a change is made to a series parallel connection, with two legs of three twin motors in series. To get full running speed a third change is made which puts three legs in parallel with two twin motors in series across the 3,000 volts.

There are two "shunting" notches on the master controller which by shunting part of the motor fields gives the maximum possible speed of the locomotive.

Up to approximately ten miles an hour and also during regeneration, the air compressor and if required the blowers, are driven by the motor generator, the motor of which operates from the 3,000 volt line. Above this speed the driving of the air compressor and blowers is changed over to axle generators, there being one on each four wheel truck. During rgeneration these axle generators are used to provide excitation for the main motor fields.

One of the features of this locomotive is that the auxiliaries and control are operated with a low voltage of approximately 85 volts. Under present operation the blowers are used for cooling the main motors only when ascending the heavier grades, and during heavy regeneration.

The motor generator is used for lighting the train, providing current for closing the various switching apparatus on the locomotive, for charging locomotive batteries, and for driving auxiliaries as explained previously.

The batteries are used to drive the air compressor for obtaining air for raising the pantagraphs, when there is less than 70 lbs. of air in the main reservoirs and also as a reserve in case of trouble on the motor generator.

These locomotive are designed to pull a 13 car steel train up the 2 percent grade at approximately 25 m. p. m., one locomotive performing the duty where formerly two passenger steam locomotives were used. To illustrate their pulling power, the writer, in the ca-

pacity of an instructor to the engineman, was on one of the passenger locomotives, which in an emergency, was taking 1,280 tons of freight from Harlowton, westbound. The 2 percent "pinch" on the Eastern slope of the Belt mountains was easily negotiated.

The regenerative feature of these locomotives in the words of the operating engineman, is especially fine. Perhaps a word should be said in a brief explanation of "regeneration." Regeneration by electric locomotives simply means that the weight of the train being propelled down by gravity, becomes a source of mechanical energy, which is transformed by the motors, acting as generators, into electrical energy, and is returned to the trolley wire to be used in the same manner as that from the power house. The locomotives due to this regenerative feature are able to descend the grade without the use of air brakes, although the main reservoirs are kept "pumped up", which means that the air brakes can be used in any emergency.

The removal of wear and tear on the braking apparatus of locomotive and train can be well appreciated by steam operating men accustomed to operating on heavy mountain grades.

The descent down the long mountain slopes under regeneration on these passenger locomotives as stated before is unanimously commented on favorably by the operating men. Once the correct speed is set, the controller is very seldom moved, the speed varying not more than one m. p. m., down the whole descent.

Regeneration can be used at speeds varying from 10 m. p. h. to maximum; depending on the profile.

These locomotives have been in operation for nearly a year and the electrical operation over this period has been well nigh perfect.

Th following is an outline of the characteristics of the Westinghouse locomotive:

CHARACTERISTICS

Total weight of locomotive	275 tons
Weight of electrical equipment	199,000 pounds
Weight of mechanical equipment	351,000 pounds
Number of driving axles	6
Classification	4-6-2-2-6-4
Capacity—one hour rating	4,200 H. P.
Capacity—continuous rating	3,400 H. P.
Tractive effort—one hour rating	66,000 pounds
Tractive effort—continuous rating	49,000 pounds
Speed—maximum	65.0 m. p. h.
Capacity of steam heating boiler	4,000 pounds per hour
Capacity of oil storage tanks	750 gallons
Capacity of water tanks	25,250 pounds
Voltage of trolley	3000 D. C.

150 ft. two stage air compressor.

Membership Dues

At the annual meeting held last January the constitution of the Society was amended, changing the beginning of the fiscal year from January 1st to June 1st. The annual meeting of the Society will be held under the constitution, as amended, in June.

This change in the constitution involves a considerable change in the billing of dues. Those members of the Society who were elected prior to the amendment of the constitution will be billed this coming year for the five months period, January to May, inclusive . On June 1st they will again be billed for a full year's dues. This extra billing entails a considerable amount of work in the bookkeeping department of the Society. Prompt attention to the notices will be appreciated.

NEW MEMBERS

At the meeting of the Board of Direction, held Nov. 22, 1920, the following new members were elected:

122 Alfred McMurdie, 107 N. Clarendon St., Kalamazoo, Mich...........Junior
117 D. E. Jones, 1509 Monadnock Blk.................................Junior
137 R. C. Wieboldt, 1554 W. Van Buren St..........................Member
143 George Braun, Jr., 2619 N. Lawndale Ave...........................Junior
145 Frederick Arthur Pement, 5217 S. Kostner Ave.................Associate
149 Richard F. G. Campbell, 76 W. Monroe St.........................Student
150 George N. Simpson, 1220 E. 75th St..............................Member
151 James H. Watt, 3408 Michigan Ave...............................Student
152 Sam L. Kelisky, Care Thompson Starret Co., Broadway and Erie Sts., Milwaukee, Wis.................................Junior
153 Frank H. Bernhard, 4711 N. Monticello Ave....................Member
135 Harry R. Allensworth, 1696 Marshall Ave., St. Paul, Minn..........Member
140 Nathan Lesser, 4403 LaCrosse Ave............................Associate
142 Grant Allyn Caproni, 657 Leland Ave., Salt Lake City..............Member
144 William James Stehliy, Algonquin, Ill........................Associate

APPLICATIONS RECEIVED

Applications for membership were received by the Board of Direction since its meeting held November 22nd, 1920, as follows:

158 Garfield J. Stell..............................935 Karlov Ave., Chicago
159 Chas. K. Morgan.........................1724 Summerdale Ave., Chicago
160 M. E. Webster................................113 N. Perry, Peoria, Ill.
161 W. B. Reichard...............................851 Galt Ave., Chicago
162 John W. Horesfield........................5524 W. Congress St., Chicago
163 J. A. Scanlan...............................447 Fullerton Ave., Chicago
164 Elmer F. Christenson.......................5904 Midway Park, Chicago
165 James M. McFarland.........................Lewis Institute, Chicago
166 Theodore Doll..............................913 Hamlin St., Evanston, Ill.
167 Hubert M. Henry..................1835 S. Lincoln St., North Chicago, Ill.
168 E. Merrill Seaberg...........................3599 Archer Ave., Chicago
169 John C. F. Vaaler........................3818 N. Lawndale Ave., Chicago
170 John E. Titus..............................53 W. Jackson Blvd., Chicago
171 Elbert C. Isom............................Sinclair Refining Co., Chicago
172 Arthur Joseph Warren........................1847 Addison St., Chicago
173 Wirt A. Stevens.............................7543 Saginaw Ave., Chicago
174 F. J. Brackett......................................Mt. Vernon, Iowa
175 Lineol Benjamin.............................7234 Indiana Ave. ,Chicago
176 Edwin Rohrdanz....................375 Greenwood Ave., Blue Island, Ill.
177 Eris Ragnar Lindberg........................3014 Osgood St., Chicago
178 Edwin George Baumgartner.............505 Hannah Ave., Forest Park, Ill.

Members are requested to communicate with the Secretary with regard to qualifications of the above applicants for membership in the Society.

EDGAR S. NETHERCUT, Secretary.

EMPLOYMENT SERVICE

Do you need assistants?
Do you want a position?
Do you feel that you have men in your employ that are needed more in some other position?
Do you wish a change or advancement? The service we render is to bring men together for their mutual benefit. In order to do this, we offer free of charge, this Employment Service. Will you use it?

Positions Wanted

B-795: POSITION WANTED IN MECHANICAL Drafting Power Plant or Machine design. Exp. 16 yrs. Moulding, core making, pattern making and mach. shop work. Machine design, piping, general power plant and industrial plant work. Salary, $250 per mo.

B-794: POSITION WANTED AS HYDRAULIC Engr. in connection with water power or supply or oil pipe lines. Exp. 6 years. Salary, $4,000 per year.

B-801: POSITION WANTED AS CHIEF ENGINEER, Arch. Engr., or Chief Draftsman or Genl. Superintendence. Exp. 16 yrs. as Arct. Engr. and architecture in all its branches. Licensed Structural Engr. Salary, $275 per mo.

B-800: POSITION WANTED AS SUPT. OF Heavy or Municipal Construction. Exp. 8 yrs., R. R. Surveying and construction; 2 yrs. contractor municipal work; 3 yrs. irrigation work; familiar with concrete and steel, street paving, sewers, water mains, topography and map making. Salary open.

B-799: POSITION WANTED AS SALES ENGINEER; 5 yrs. exp. in elec. appliances, development, manufacture and sales work. Salary, $4,000 per year.

B-798: POSITION WANTED AS MECH. DETAILER, 3 yrs. exp, conveying machinery and coaling stations. Salary, $175 per mo.

B-797: POSITION WANTED IN MECH. CONSTRUCTION or power research. Exp. 4 years on boiler and furnace construction and mach. shop practice. Salary, $150 per mo.

B-796: POSITION WANTED IN ELECTRICAL or automotive engineering or along mech. lines, ignition and lighting; 2 yrs. exp. Salary, $165 per mo.

B-806: POSITION WANTED AS MECH. ENGINEER, tech. grad.; 7 yrs. exp. Salary, $250 per mo.

B-805: POSITION WANTED BY GRAD. C. E. Armour Inst., 1911; Exp. 3 yrs., mining; 4 yrs. building const. supt. Wishes connection as estimator for contractor or with an industrial concern.

Positions Wanted

B-803: POSITION WANTED AS MINE MGR. or prof. work along mining engineering lines, such as examinations and consultation; 19 yrs. exp., from laborer underground to gen. mgr. Salary, $12,000.

B-802: POSITION WANTED AS MANAGER or executive engr. by grad. C. E.; well posted along mech. and elec. lines. Exp., supt. and supv. of construction, large power station and terminal layouts; age 39, married. Salary open.

B-811: POSITION WANTED IN POWER House construction, or design with public utility company, by grad. Pratt Inst. Elec. Engr. Salary, $35 per week.

B-810: POSITION WANTED AS DRAFTSMAN by man with experience on railroad mtnce. and oil company work. Salary, $175 and expenses.

B-809: POSITION WANTED AS TRACER ON residence drawing or making working drawings from sketches; 2 1-2 yrs. exp in arch. drafting. Is willing to start as tracer with concern offering good future. Salary, $125 per month.

B-808: POSITION WANTED AS PLUMBING and heating draftsman, arch. draftsman or plumbing and heating specification writer; 7 yrs. exp. in plumbing and heating; 4 yrs. arch. drftg. and 3 yrs. in building superintendence. Salary, $250 per mo.

B-807: POSITION WANTED AS MECH. OR structural draftsman; tech. grad.; 5 yrs. shop and 7 yrs. office experience as detailer, conveying, elevator, power plant and mining mach. work. Salary, $200 per mo.

B-817: POSITION WANTED IN CONSTRUCTION, factory maintenance or machine design by grad. M. E. Age 35; married; 10 yrs. exp. in above work.

B-816: POSITION WANTED AS ENGINEER on construction, detailer, struct. steel or engineer on concrete constr. Age 30; single; 5 yrs. experience. Salary, $225 per mo.

B-815: POSITION WANTED AS STRUCT. OR mech. draftsman on coal tipples; 5 yrs. exp. Salary, $150 per mo.

Positions Wanted—Continued

B-814: POSITION WANTED AS DESIGNING engineer and estimator, preferably with contractor or architect; 9 yrs. exp. in design of steel, re-enforced concreting constr. Salary, $250 per mo.

B-804: POSITION WANTED AS PLANT Supt., or plant Engr. Experience, design, installation, construction, mtricl., operation and production, open quarry, iron ore, concentrating, metallurgical and chemical plans, also combustion and building material exp. Salary $4,000 and bonus.

B-813: POSITION WANTED AS MECH. OR struct. checker or draftsman; 8 yrs. exp., general steel mill, open hearth, field and construction works, including installation of machy. Salary open.

Positions Wanted—Continued

B-812: POSITION WANTED AS SALES OR Combustion engr.; 6 yrs. exp., design, construction and selling industrial furnaces and forges, heat treating and general drafting. Salary, $50 per week and com.

B-818: POSITION WANTED AS STRUCTURAL engineer or architect; exp., 15 yrs. as draftsman, structural engr and architect. Salary, $4,500 per year.

B-819: POSITION WANTED AS ELEC. Engineer by grad. Armour, 1909, elec. engr. exp., 12 yrs in design, constr. and operation. Salary open.

SECRETARIES OF ENGINEERING SOCIETIES
CHICAGO, ILL.

Organization	Secretary	Address	Telephone
Am. Soc. C. E. (Illinois Section)	W. D. Gerber,	913 Chamber of Com.	Franklin 2243
A. S. M. E. (Chi. Section)	J. D. Cunningham,	2240 Diversey Blvd.	Armitage 254
A. I. E. E. (Chicago Section)	M. M. Fowler,	925 Monadnock Blk.	Har. 9800
A. I. M. E.	F. G. Fabian,	1025 Peoples' Gas Bldg.	Har. 470
Am. Ry. Engrg. Assn.	E. H. Fritch,	431 S. Dearborn St.	Har. 1069
Am. Chem. Soc.	S. L. Redman,	460 E. Ohio St.	Sup. 7920
Am. Soc. Htg. & Vent. Engrs.	Benj. Nelson,	1301 Monadnock Blk.	Wab. 9038
Am. Soc. Refrig. Engr.	Thos. McKee,	431 S. Dearborn St.	Har. 5643
Am. Steel Treaters Soc.	H. Blumberg,	Ill. Steel Co., S. Chgo.	S. Ch. 4000
Am. Inst. Architects	Ed H. Clark,	8 E. Huron St.	Sup. 1461
Assn. I. & S. Elec. Engrs.	W. H. Williams,	1501 Monadnock Blk.	Har. 1190
Am. Assn. of Engrs.	W. H. Dean,	29 S. LaSalle St.	Cent. 73
Am. Welding Soc.	L. B. Mackenzie,	608 S. Dearborn St.	Wab. 7134
Ill. Soc. of Architects	Ralph C. Harris,	192 N. State St.	Rand. 2409
Ill. Soc. of Engrs.	E. E. R. Tratman,	1570 Old Colony Bldg.	Har. 2196
Illuminating Eng. Soc.	Jas. J. Kirk,	72 W. Adams St.	Rand. 1280
Natl. Assn. Prac. Ref. Engrs. (Chicago Subordinate)	E. H. Fox,	5707 W. Lake St.	Austin 1303
Soc. Automotive Engrs. (Mid-West Section)	L. S. Sheldrick,	910 S. Michigan Ave.	Har. 1455
Soc. Industrial Engrs.	Geo. C. Dent,	327 S. LaSalle St.	Wab. 3291
Struct. Engrs. Assn.	John P. Cowing,	30 N. LaSalle St.	Frank. 778
Sewidsh Eng. Soc. of Chicago	C. H. Mayer,	404 Monroe Bldg.	Rand. 6120
Western Society of Engineers	E. S. Nethercut,	1736 Monadnock Blk.	Har. 945

CURRENT NEWS SECTION

JOURNAL OF THE
WESTERN SOCIETY *of* ENGINEERS

Volume XXVI FEBRUARY, 1921 Number 2

Agricultural Engineers Promote Standardization

The annual meeting of the American Society of Agricultural Engineers which was held December 28th, 29th and 30th, at the Hotel Sherman, Chicago, had as its outstanding feature a larger measure of usefulness on the part of the society to agriculture, to related industries and to educational work in agricultural engineering. This was true not only of the progress during the year just closed but also in the work under way for the future.

S. H. McCroy, of the Division of Agricultural Engineering, U. S. Department of Agriculture, in the course of a report brought out the need for better means of contact between the work he represents and the departments of agricultural engineering in the various universities with whom and among whom it is obviously desirable to maintain correlation of effort, particularly in research work. Steps were taken toward the formation of a special section of the society consisting of its members directly representing the institutions mentioned to act as a clearing house and coordinating agency. While many of the State university departments as well as the Division of Agricultural Engineering of the U. S. D. A. are well represented in the society provision is made for the admission without restriction of representatives from all state university departments to this section. It is understood that this section will be practically independent of the society as a whole and its functions will be advisory only, its purpose being only to facilitate and make more efficient the combined work of the public agencies already existing.

Much interest attached to the report of the Standards Committee, presented by Raymond Olney, chairman, as it is through this committee that the society carries on its standardization work in connection with the National Implement and Vehicle Association and the American Agricultural Equipment Standards Committee. In addition to a report of work already accomplished and that in progress the report contained recommendations for a better and more comprehensive organization of the committee together with suggestions for minor changes in the constitution of the society to permit better articulation of its work with that of its collaborators in the standardization work.

The society dinner the evening of the 29th had as its feature talks by C. E. Gunnels, treasurer, and J. R. Howard, president, of the American Farm Bureau Federation. Mr. Gunnels spoke briefly on the organization, scope and purposes of the federation, emphasizing its representative character and the fact that it is proceeding along sound, economic lines and avoiding political activity or bias. Mr. Howard, after calling attention to the fact that every item of farm operation or farm improvement involved agricultural engineering in its execution, proceeded to set forth the present economic and financial situation in its relation to the farmers of the country and showed how this situation would affect the agricultural engineers, particularly in their commercial connections. He made it very plain that the purchasing power of the farmer's dollar must be materially increased before there can be any great measure of prosperity in the various industries which directly or indirectly are dependent on agriculture.

"Psychological Tests for Technical Efficiency in Agricultural Engineering" was the subject under which F. W. Ives, of the Agricultural Engineering Department, Ohio State University, presented the results thus far secured by Dr. H. E. Burtt, professor of psychology at the same institution, in the devising and application of psychological tests to determine the probabilities of success of students preparing for agricultural engineering as a profession. It may be stated that the results thus far secured, even though the tests are far from being perfected, are not always conclusive but in most cases are distinctly helpful.

E. V. Collins, Assistant Chief Agricultural Engineer of the Iowa Experiment Station, reported further progress in testing the draft of plows. One interesting development which may be mentioned is the fact that the increase in draft with speed, reported a year ago, applies to all standard types of plows, and that moldboards with a gentle turn, such as breaker bottoms, do not ordinarily have the comparatively light draft with which they are credited. Other important papers included "Land Clearing With Dynamite," by Arthur L. Kline, Hercules Powder Company, Wilmington, Delaware; "Wagon Standards,' by E. E. Parsonage, John Deere Wagon Works, Moline, Illinois; "Preservative Treatment of Timbers in Farm Structures," by E. C. Mandenberg, of the Barrett Company, Chicago; "Artificial Heating of Animal Shelters" by K. J. T. Ekblew, engineering editor, "National Farm Power," Chicago, Illinois; and "Tractor Testing," by O. W. Sjogren, head of the Agricultural Engineering Department, University of Nebraska.

In giving the report of the Tractor Committee the Chairman, A. N. Gilbert, of the Rock Island Plow Company, stated that considerable study had been given to future tractor fuel, with the conclusion that fuel alcohol can be produced on a basis which will prevent fuel famine or prohibitive cost. It appears that a bushel of corn will yield about two and one-half gallons of one hundred per cent alcohol and proportionately more of a less refined product. It is claimed that the feed left as a by-product will cover the cost of distilling and that the only real obstacle to economical production and distribution of alcohol fuel is the excessive amount of restriction and red tape imposed by the government. Mr. Gilbert predicted that the time would come when the corn fields of Illinois and Iowa would compete with the oil fields of Oklahoma and Texas. The committee also is at work on tractor lug equipment.

Other committee reports calling for special mention include that by R. W. Trullinger, specialist in Rural Engineering, States Relations Service, U. S. D. A., for the Research and Data Committee, being a discriminating review of real research in agricultural engineering at the various experiment stations and in fact throughout the world. W. C. Kaiser, of the Portland Cement Association, chairman of the Committee on Farm Structures, presented a report on the design of the farm elevator, a term used to designate buildings combining the granary and corn crib and designed for the use of emptying the cribs. Progress in barn cribs and bins, and also taking into account the sheller drag often used in modern power elevators in filling the ventilation was reported by W. B. Clarkson, Kind Ventilating Company, chairman of the committee covering that field. The progress of agricultural engineering in drainage was reported by S. H. McCrory, Division of Agricultural Engineering Company, Mitchell, South Dakota.

At the closing session F. N. G. Kranich, the president during 1920, called on E. A. White, president-elect, to assume the duties of that office.

European Relief Council

No more important cause has been presented since the Great War than the Hoover Relief for the starving children of Europe.

This is especially a call that Engineers will recognize because it is entirely under the direction of Mr. Hoover.

The response to the appeal at the January Luncheon was gratifying. Sixty-five subscriptions amounting to $638.00 were quickly secured.

The members who have not given so far are urged to send in their quota to the Secretary's office promptly.

Three cents per day will save a child. How many children can you save?

Mrs. Daniel Leavitt Mansfield announces the marriage of her daughter, Miss Irene Mansfield, to B. F. Affleck. The wedding took place January 14th at Chicago.

National Rivers and Harbors Congress

The National Rivers and Harbors Congress, assembled in the City of Washington, at its sixteenth annual session, and represented by delegates from all sections of the country, submits the following declaration of its policies, purposes and desires:

A National Organization. This is a national organization to promote and increase the facilities for and use of transportation by water. It stands for a policy and not a project. It is national in spirit and not sectional.

Production, Distribution and Terminals. The ever increasing productiveness of the country necessitates an increase in its transportation facilities—railway, waterway and highway—which must be coordinated. Therefore, terminals, including physical connections between these transportation facilities, must be provided by states and localities, as required by the Federal Government. Co-operation is urged between the United States Engineers and local authorities in planning of such terminals, so that harbor lines as established and facilities provided by the Federal Government and by local authorities shall be full coordinated.

Recent Progress in Legislation. We commend the action of Congress in the enactment of the Transportation Act of 1920, in so far as it includes many of the recommendations of this organization in the interest of water transportation.

We are also grateful to Congress for its action in the passage of a water power bill, which is an initial step toward legislation recommended by this organization.

Comprehensive Waterways Plan. We urge upon Congress the adoption, with as little delay as possible, of a plan for the entire country of a comprehensive system of waterways, connected wherever practicable, and in the formulation of such plan military needs should be carefully considered. Such plan, when adopted, should be pushed to early completion, first attention to be given to the main rivers and canals which may be regarded as trunk-line channels of a general national system of water highways, the work on these main lines to be prosecuted as rapidly as possible so as to permit their prompt use.

Use of Waterways. We call the earnest attention of the people of the country to the fact that navigable waterways are intended primarily for commerce, and the expenditure of public moneys for their improvement can only be justified when they are to be used for this purpose. We again urge the use of the waterways to the fullest possible extent.

Prosecution of Authorized Work. The vital need of increased transportation facilities demands the earliest possible completion of all projects approved by the U. S. Engineers and authorized by Congress. We therefore urge that the Congress appropriate each year the minimum amount of money requested by the Engineers to enable them to carry on the work of the several projects as planned, and we are unqualifiedly of the opinion that the object sought can best be obtained by placing all such work under the continuing contract plan.

OFFICERS 1920-21.

President—Hon. John H. Small, Washington, D. C.

Secretary-Treasurer—S. A. Thompson, Washington, D. C.

Director for Life—Capt. J. F. Ellison, Cincinnati, Ohio.

Director for Life—Hon. Jos. E. Ransdell, Lake Providence, Louisiana.

Sergeant-at-Arms—Col. John I. Martin, St. Louis, Mo.

Whiting Corporation

The name of the Whiting Foundry Equipment Company has been changed to Whiting Corporation. The general offices and works are located at Harvey, Illinois, where they manufacture electric traveling cranes and complete foundry plants.

Acknowledgment

The Western Society of Engineers gratefully acknowledges receipt of the following framed photographs for use in its quarters:

Armour's Northwestern Grain Elevator, Chicago; donor, Universal Portland Cement Company, Chicago.

Plant of the Seaboard By-Product Coke Company, Jersey City, N. J.; donor, The Koppers Company, Pittsburgh, Pa.

Tom R. Wyles, Aff. W. S. E., has been elected president and Fred A. Preston, Aff. W. S. E., appointed on the Board of Governors of the Exmoor Country Club.

American Motor Bus Corporation

Harold Almert, M. W. S. E., Consulting Engineer, has recently submitted a report on the American Motor Bus Corporation and the Chicago Motor Bus Company, and the business of the two concerns has been taken over by The Lake Shore Motor Bus Corporation, a holding company.

The American Motor Bus Corporation, the manufacturing concern, has resumed the manufacture of front wheel drive, stepless type, motor busses and are bringing out a new double deck bus with a seating capacity of sixty passengers, with both upper and lower decks fully enclosed. The initial order will keep the factory operating at full capacity for the year 1921.

The Chicago Motor Bus Company, which operates a fleet of motor busses over the boulevards of the north side of Chicago, serving a territory which cannot be reached by the surface and elevated railways, has obtained an amendment to its franchise permitting the operation of the new enclosed top bus and will increase its service on the north side and shortly start operation on the south side, together with throught routes between the north and south sides.

Research Graduate Assistantships

Engineering Experiment Station, University of Illinois.

The Engineering Experiment Station of the University of Illinois, an organization within the College of Engineering, was established in 1903 for the purpose of conducting investigations in the various branches of engineering, and for the study of problems of importance to engineers and to the manufacturing and industrial interests of the State of Illinois. Research work and graduate study may be undertaken in architecture, architectural engineering, ceramic engineering, chemistry, civil engineering, electrical engineering, mechanical engineering, mining engineering, municipal and sanitary engineering, physics, railway engineering, and theoretical and applied mechanics.

Announcement is made of the appointment to the Research Graduate Assistantships which are maintained by the Engineering Experiment Station. Applications for appointments to these positions should be sent to the Director by March 1, 1921. There will be thirteen vacancies, and in addition two in Gas Engineering, to be filled at the close of the current academic year.

Additional information may be obtained by addressing, THE DIRECTOR, Engineering Experiment Station, University of Illinois, Urbana, Illinois.

Oak Lasts For Centuries

In driving a new gallery in a gold mine at Victoria, Australia, at a depth of 300 feet, pieces of oak timber were found perfectly preserved and with the appearance of having been sawed and shaped by man. The timber lies in an ancient river bed.

Just before the war it was discovered in Russia that the bed of the Moksha river, for a length of 400 miles, was full of magnificent oak trees.

Oak has the peculiar property of lasting for centuries when buried in water or wet sand. Oak piles from bridges constructed by the Romans have been found to be as sound as when placed, nearly 2,000 years ago.

LIBRARY SERVICE

MISS ELTA VIRGINIA SAVAGE, Librarian

The following periodicals have just been added to the current file:

American Chemical Society—Chemical Abstracts.

Automotive Industries.

National Petroleum News.

Metal Industry.

Telegraph and Telephone Age.

If there are other periodicals which you should like to see in the file, please come in and tell us about them while there is still time to obtain the first issues of the year.

In order to complete files the Library needs:

Chemical and Metallurgical Engineering for 1915, 1916, 1917.

Engineering and Mining Journal for 1917 and 1918.

Machinery, volume 23, 1916-1917 and volume 24, 1917-1918.

International Marine Engineering for 1916, 1917, 1918.

If any member has unused files in the attic or storeroom, we should appreciate the opportunity for making them available for the society.

Book Reviews

"Retaining Walls, Their Design and Construction," by George Passwell, C. E., published by the McGraw-Hill Book Co., New York, 1920, is one of the latest contributions to engineering literature on this subject. The book is divided into two parts. Part I, on design, contains five chapters headed "Theory of Earth Pressures," "Design of Gravity Walls," "Design of Reinforced Concrete Walls," "Various Types of Walls," and "Temperature and Shrinkage Stresses." Part II, on construction, consists of six chapters headed "Plant," "Forms," "Concrete Construction," "Walls Other Than Concrete," "Architectural Details, Drainage and Waterproofing," and "Field and Office Work." An appendix contains typical specifications and an extensive bibliography. Shorter bibliographies follow some of the individual chapters.

The question naturally arises as to whether the subject of retaining walls is of sufficient magnitude to justify a separate volume. Necessarily it involves the duplication of much previously published material. This is especially true of portions of the chapters on the theory of earth pressure and the design of gravity walls in Part I, and the portions of Part II pertaining to concrete construction.

However, the book is fully justified from several standpoints. In the first place, it collects into one volume the most modern practice in the design and construction of retaining walls. Second, it gives numerous examples of types of walls not usually mentioned in text books, but frequently encountered in actual practice. Every designer of retaining walls who has had experience with railway track elevation or depression work in large cities knows that the usual treatises on this subject are confined to the more common types of walls, and are entirely inadequate as referenced. In track elevation and depression work the walls must be confined within definite right-of-way lines, and every inch counts. Traffic must be kept moving during construction. Engineers have devised many types of walls and schemes of construction to meet such conditions, and in this book many of them will be found. Notable among them are the cellular retaining walls used in track elevation work in Chicago and Milwaukee. The important subject of equivalent surcharge for superimposed stationary and movable loads, a matter usually ignored or passed over very lightly in text books, is treated thoroughly in this book, both in the regular text and in illustrative examples.

In his review of mathematical theories of earth pressure, the author calls attention to the fact that most mathematical analyses are based on an ideal earth, consisting of a granular, homogeneous mass, devoid of cohesion and possessing frictional resistance. While admitting that such an earth fill rarely exists, in actual practice, he takes the logical position that the mathematical analysis nevertheless establishes the probably maximum pressure, which may be reduced in accordance with available experimental data. A commendable feature of this chapter is the treatment of equivalent surcharge, previously mentioned.

The chapter on gravity walls contains a solution of the pressure on piles under retaining walls, with an illustrative example. Chapters III. and IV., on reinforced concrete walls and on various types of walls, contain some of the best material in the book, certainly the most important from the designer's standpoint.

In Part II, construction superintendents will find many valuable suggestions in the chapters on plant layout and form work. These chapters are valuable also in cases where tentative plant layouts and form designs must be prepared in the office in advance of construction. The chapter on concrete construction contains the latest developments pertaining to the proper proportioning, mixing, placing and curing of concrete. The author draws liberally on the results established by the investigations of D. A. Abrams, L. N. Edwards, A. N. Talbot, N. C. Johnson and others.

This volume will be a valuable addition to the personal libraries of designing engineers and construction superintendents whose work comes within the scope of the book. It should be of particular interest to engineering departments of railways, for it will give both the office and the field forces a broader knowledge of their own work, and will give each of these forces a better appreciation of the difficulties encountered by the other. The book has a few mechanical flaws common to first editions. For instance, the Appendix is without a heading, and the chapter headings in the table of contents do not in all cases agree with those in the text. These flaws will no doubt be corrected in later editions.

NORMAN M. STINEMAN.

"Fuel Oil in Industry," by Stephen O. Andros, The Shaw Publishing Co., Chicago, 1920.—The general interest in the subject of crude oil due to the constantly increasing demands for both refined products and fuel oil and the limited visible supply according to various experts, together with the general scramble of nations and powerful corporations to control the sources of production has evidently been the reason for publication of this book.

Elementary principles of combustion are considered in Chapter I. Several succeeding chapters treat on the properties of fuel oil, comparison with other fuels, distribution and storage, (this chapter includes National Fire Protection rules and New York and Chicago regulations), and preparation of fuel oil for practical combustion.

Various types of spray burners are illustrated diagramatically and principles of operation are described. Finally there are several chapters devoted to use of fuel oil for specific service, such as in boiler furnaces, industrial furnaces and in various industries.

While some valuable information is presented it is distinctly apparent that the work is superficial, clearly a compilation from a number of sources and derived from personal research or experience only to a limited extent. Common forms of apparatus are considered but the later developments in the art are not mentioned.

Proof reading has been sadly neglected, errors in calculations and text giving entirely different meaning than intended.

The use of cuts having little or no reference to the text, as in this work, is a practice that certainly should be criticised.

There is a field for such a book but a much better might be written.

G. R. Brandon.

Rental of Auditorium, Western Society of Engineers

The following dates are available in February for night meetings: February 4th, 9th, 10th, 23rd and 24th. If you know of any society or organization wishing a central meeting place on any of the above dates where evening meetings are desired, kindly phone the Secretary's office.

Capt. E. V. Lippe has been appointed a member of the Materials and Methods Committee in place of J. B. Blake, resigned.

NOON DAY LUNCHEON

J. H. LIBBERTON, Chairman.

Although Thomas R. Preece, Vice-President of the Bricklayers, Plasterers' and Stone Masons' International Union of America, was unable to be present on Friday, January 14, we were fortunate in securing Mr. Harry Newman Tolles, Vice-Preisdent of the Sheldon School of Salesmanship.

Mr. Tolles pointed out that everyone is a salesman, no matter what his particular line of business. He called attention to the necessity on the part of both employer and the employee to realize that service is essential. Guided by this thought the unselfishness which is so striking in most modern businesses would be considerably modified. Mr. Tolles called attention to the fact that the engineer stands midway between labor and capital and that he must necessarily study both sides of each question in order that he may serve to the best advantage.

Mr. Tolles read the following poem which is printed in response to the many requests of those who attended the Luncheon:

NOT UNDERSTOOD

By Thomas Bracken

Not Understood, we move asunder,
Our paths grow wider as the seasons creep
Along the years. We marvel and we wonder
Why life is life, and then we go to sleep—
Not Understood.

Not Understood, we gather false impressions
And hug them closer as the years go by,
Till virtue oft seems to us transgression
And thus men rise and fall and live and die—
Not Understood.

Not Understood, poor souls with stunted vision
Oft measure giants by their narrow gauge;
The poisoned shafts of falsehood and derision
Are oft impelled 'gainst those who mold the age—
Not Understood.

Not Understood, we make so much of trifles;
The thotless sentence or the fancied slight
Hast oft destroyed a friendship years in making
And on our souls there falls a chilling blight—
Not Understood.

Not Understood, how many breasts are aching
For words of sympathy. Ah! yes, today
How many hungry hearts are breaking,
How many noble spirits pass away—
Not Understood.

Oh God, if men could see a little clearer
Or judge less harshly when they cannot see;
Oh God, if men would draw a little nearer
To one another, they'd be nearer then to Thee—
And Understood.

Representatives of the Hoover Relief gave short talks, calling attention to the fund that is now being raised. Subscriptions amounting to over $600 were promptly given.

Arrangements are being made to secure several prominent speakers for the ensuing months, the dates tentatively arranged being February 11, March 11, and April 8.

U. S. Public Health Service Studies New Jersey Foundries

The comprehensive study of the health conditions prevailing in the brass and iron foundries of New Jersey and New York, which was begun six months ago by the U. S. Public Health Service, is drawing to a close, with results that are said to be extremely interesting and valuable.

"The Commissioner of Labor of New Jersey," says Surgeon General Cumming, o fthe Public Health Service, "realizing the need for scientific information on health hazards in the foundry trades, asked the Service some months ago to send specialists to study the trade processes and working conditions obtaining in the brass and iron foundries so that it might advise him wisely in regard to any regulations governing these hazards that might be proposed. His request was seconded by the plant managers, who co-operated enthusiastically in the study.

"In the foundries, as in other branches of industry, the health of the workers is, of course, of the first importance, from both a humane and a business point of view. Ill health causes sickness, absenteeism, accidents and loss of trained men, all of which result in decreased efficiency and reduced output ofr the plant, causing physical and economic losses to both men and owners.

"The Service gladly accepted the invitation and sent industrial engineers to analyze the plant processes and working conditions and industrial physicians to make physical examinations of the men, thus ascertaining whether working conditions existed that might be expected to react adversely on the health of the workmen and also what physical defects or ailments were actually afflicting the men. Knowledge of these data were, of course, essential as a basis for an attempt to evaluate the actual occupational heat hazards.

"The chief hazards of foundry work are those associated with production processes, that is of high heat temperatures, which are essential in parts of the plants; of smoke, gas and fumes, which are evolved in sundry phases of the work; and of dust, liable to be noxious, which is produced abpntantiy in the sandblast, tumbling and grinding rooms, where castings are reduced to final form.

"To these hazards are added those due to poor plant architecture, inadequate or unsanitary personal service facilities, and unhygienic conditions resulting from inadequate lighting and lack of attention to cleanliness in work rooms ,windows, globes, and similar essentials.

"All of these hazards were studied closely and tentative protective regulations were devised. Chief attention, however, was given to the fumes and the dust, which were believed to be the factors most likely to cause trouble. The investigation made of the sandblast process and its effects was probably the most complete ever made.

"All the data have not yet been assembled; but tentative conclusions indicate that industrial hygiene can no longer be considered merely as a matter of sanitation but must be widened to include fundamental factors associated with plant processes and the materials therein. A flattering result of the work has been the cheerful reception by the plants of the recommendations of the Service in regard to the eliminating of the hazards found.

National Research Council Officers 1921

George E. Hale, Honorary Chairman, Director, Mount Wilson Observatory, Carnegie Institution of Washington, Pasadena, Cal.

Henry A. Bumstead, Chairman, Professor of Physics, and Director of the Sloane Physical Laboratory, Yale University, New Haven, Conn.

Charles D. Walcott, First Vice-Chairman, Secretary of the Smithsonian Institution, and President of the National Academy of Sciences, Washington, D. C.

Gano Dunn, Second Vice-Chairman, President, J. G. White Engineering Corporation, 43 Exchange Place, New York, N. Y.

R. A. Millikan, Third Vice-Chairman, Professor of Physics, University of Chicago, Chicago, Illinois.

Vernon Kellogg, Permanent Secretary, National Research Council, Washington, D. C.

F. L. Ransome, Treasurer, Geologist, U. S. Geological Survey, and Treasurer of the National Academy of Sciences, Washington, D. C.

Alfred D. Flinn, Assistant Secretary, Secretary of the Engineering Foundation, 29 West 39th street, New York, N. Y.

A. E. R. A. Mid-Year Conference

An invitation has been extended, through its Secretary, Mr. E. B. Burritt, to the members of the Western Society of Engineers and the Chicago Section of the American Institute of Electrical Engineers to attend the mid-year meeting of the American Electrical Railway Association which will be held in Chicago at the Drake Hotel on February 10th, 1921.

Financing and re-financing of Electric Railways is the general subject for discussion at the day sessions of the Conference.

Mr. J. D. Mortimer, Chairman of the Committee on Subjects, has announced the following papers for the program at the Chicago convention:

"Previous Methods of Electric Railway Finance," by James F. Fogarty, secretary of the North American Company, New York. This paper will give a summary of the changing methods of financing capital improvements from the days of early electrification down to the present, with reasons therefor; influence of low rates of return on such methods, as disclosed by the large proportion of capital securities represented by interest-bearing debt; influence of the holding company and probable future; war-time financing; post-war financial methods.

"Present Requirements for Mortgage Securities," by F. K. Shrader, Halsey, Stuart & Company, Chicago. In this paper Mr. Shrader will give an analysis of what competition requires in the way of relation of cash invested to amount of loan; influence of previous history on electric railway investments; margin of earnings over interest charges; flexibility of mortgage provisions; necessity of ample stable earnings as a condition precedent to re-establishment of credit to be derived fro mautomatic regulation or cost-of-service franchises; characteristics of interest bearing securities which the general market is likely to absorb during the next year or two.

"Home Town Financing—Partial Mutual Ownership," by S. B. Way, vice president and general manager the Milwaukee Electric Railway and Light Company. This paper will describe the desirability of large localinterest being held by car riders; influence on local regulatory ordinances, etc.; cost of capital procurable by this means; methods of distribution.

"Necessity of Financing by Sale of Capital Shares," by Chester Corey, vice-president Harris Trust & Savings Bank, Chicago. Mr. Corey in this paper will point out the importance of providing for return on new capital that will invite the investment of new money through the purchase of issues of capital stock; requirements in the way of franchises or methods of regulation which will support such plans of financing.

"Municipal Aid in Electric Railway Financing," by Melvin A. Traylor, president First Trust & Savings Bank, Chicago. This paper will give the conditions under which municipal co-operation is required; moral support and abandonment of the street railway as a political issue; pledge of municipal credit through guarantees; municipal aid for rapid transit in construction of subways an delevated lines.

The dinner will be held at The Drake, Chicago, February 10th, 7 o'clock sharp. Tables will seat ten persons each and it is important that those desiring whole table should make early application.

Dinner reservations should be accompanied by remittance of ten dollars per plate and forwarded to L. E. Gould, Chairman, Room 1590 Colony Building, Chicago.

Mayor Thompson's Traction Plan

A commission appointed some months ago have reported an endorsement of the plan of the Mayor to establish a Traction District to include Chicago and suburban—this district to own and operate the street railways. It is urged that by this means a 5 cent fare can be secured.

The City Council Committee on Local Transportation have recommended an ordinance asking the State Legislature to pass legislation which will permit Transportation Districts to organize as separate taxing bodies.

The Public Affairs Committee will give this matter considerable consideration—when the engineering features are developed.

The following letter has been sent to the committee:

January 17, 1921.

Hon. U. S. Schwartz, Chairman,
Committee on Local Transportation,
Chicago, Illinois.

Dear Sir:

Relative to action your Committee purposes to take upon the report of the Commission on Local Transportation of the City of Chicago, in accordance with

the ordinance of the City Council adopted November 10, 1919:

We wish to take this opportunity of advising that the Western Society of Engineers feels that it is most vitally interested in this matter and at the proper time intends to make an investigation and report upon the proposed traction plan, with a view of enlightening its members and the general public upon engineering and other questions involved.

The time is too short to make such investigation now and we can only call your attention to the fact that the proposed action in seeking enabling legislation from the State Legislature does not base this request upon any specific engineering plan and what outline has been os far presented omits from the proposed traction plan such vital questions as subway and elevated transportation, and further than that proposes the creation of an additional taxing body, rather than consolidation of existing governmental agencies.

The matter has been represented in the public press as having been endorsed by engineers although at the present time no such general endorsement has been made nor is there any basis for engineering approval or disapproval.

Respectfully,
ANDREWS ALLEN,
Chairman Public Affairs Committee,
Western Society of Engineers.

Engineering and Public Welfare

In the October Journal Western Society of Engineers a report by the Hydraulic, Sanitary and Municipal Engineering Section was printed.

The Board of Direction, realizing the importance of this report, referred it to the Public Affairs Committee. A sub-committee has reported making certain recommendations which the Board have approved in principal. Consideration is now being given to the necessary details.

The report contains the following: "Members of the Western Society of Engineers, as professional engineers and citizens interested in questions affecting the public welfare, are alive to the importance of active and altruistic interest and co-operation with public officials, civic and other agencies on these problems and the Western Society recognizing the responsibility and opportunity for constructive work in promoting public welfare, should be in a position to initiate and maintain leadership in the study, discussion and solution of public engineering problems.

The Committee believes that the Society has already established a policy of professional investigation and co-operation with public officials and civic and industrial agencies on engineering questions dealing with public welfare. The varied activities of the Committee on Public Affairs, the report on "Zoning" made by one of our members appointed by the Society for this purpose, the inspection trips on public engineering works in Canadian and American cities, and the appointment of two members of the Society to co-operate with the City Engineer, the Association of Commerce and other civic bodies in the matter of the proposed plan of city water works development for the next twenty years, are excellent examples of the accepted policy of our Society. And as co-operation of the Western Society in these matters has been requested not only by public officials but by private individuals and bodies, the Committee believes that the dignified policy of the Western Society meets with their approval, an asset of inestimable value to the Western Society and to the profession at large.

The Committee further believes that this policy of initiation, study and presentation of facts and unbiased opinion on public engineering questions in co-operation with governmental officials, the press, civic bodies and other agencies should not only be further encouraged and fostered but also recognized as a responsibility and duty of the Society which cannot be delegated to any other agency.

The Art Institute of Chicago

Chicago has many institutions that contribute largely to the advancement of its citizens. The Art Institute is one of the most important and useful. It is convenient, always interesting and instructive.

During February there will be two exhibitions:

The Twenty-Fifth Annual Exhibition by Artists of Chicago and Vicinity.

The Eleventh Annual Exhibition of Etchings, under the management of the Chicago Society of Etchers.

Joseph E. Nelson & Sons announce the appointment of J. B. French, M. W. S. E., as Chief Engineer of that firm.

PAUL L. WOLFEL

Paul L. Wolfel, Chief Engineer of the McClintic-Marshall Company, of Pittsburgh, died at Philadelphia December 28, 1920, after an illness of several months. He was born in Dresden, Saxony, April 19, 1861, and after completing a course in civil engineering at the Dresden Polytechnikum came to the United States in 1887. In 1900 he was made chief engineer of the American Bridge Company and in 1905 became consulting engineer, in which position he remained until June 30, 1908, when he resigned to become chief engineer of the McClintic-Marshall Company.

Mr. Wolfel was considered one of the foremost bridge engineers of his time, and was prominently identified with some of the greatest achievements in bridge design. He was a member of the Western Society of Engineers from January 3, 1903, until the time of his death.

ROBERT C. SATTLEY

Robert C. Sattley, Valuation Engineer of the Chicago, Rock Island & Pacific Railway, died December 31, 1920. Born at Ferrisburg, Vt., November 26, 1856, he, like many other well-known engineers, started westward when a young man. In 1879 he began as rodman on the Northern Pacific Railway and was with that road until 1895, working his way up to assistant engineer. Mr. Sattley was in railway construction in the days when fighting Indians was part of the day's work and his many friends will recall the interesting experiences which he so often enjoyed relating. He was subsequently with the Chicago & Northwestern Railway, serving as assistant engineer, superintendent of bridges and buildings and division engineer. Later he was with the state of Minnesota as assistant engineer on valuation work and in January 1909 was appointed assistant engineer for the Chicago, Rock Island & Pacific Railway, serving that company continuously until the time of his death. Mr. Sattley was a member of the American Railway Engineering Association, Chicago Engineers' Club and the Western Society of Engineers.

BENJAMIN THOMAS

Benjamin Thomas died at his home in Chicago January 6, 1921, after an extended illness. He was born in Towonda, Pa. He entered the service of the New York, Lake Erie & Western R. R. as train dispatcher in 1865 and worked his way up to the position of General Superintendent of that road. In 1888 he was made Vice-President and General Manager of the Chicago & Western Indiana and the Belt Railway of Chicago. In 1891 he became President of these roads. He was Chairman of the General Managers' Association for fifteen years and an Associate Member of the Western Society of Engineers since 1891.

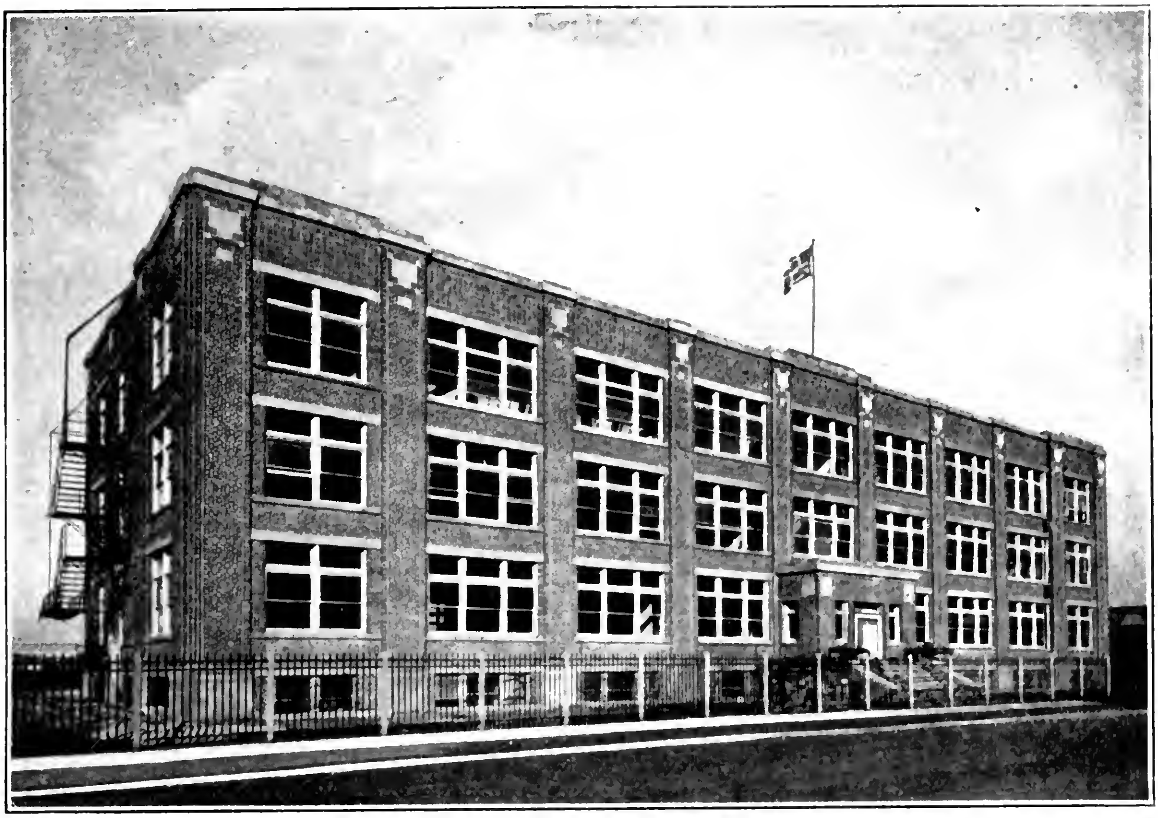
YOUNG MEN'S FORUM

BENJAMIN B. SHAPIRO, Chairman.

Are you old in years, gray in hairs, wrinkled in skin, or need assistance in going from one place to another? If so, none of these will bar you from attending the meetings of the Young Men's Forum. The only qualifications necessary are that you should be young in spirit and have the Society's interest at heart. The meetings held are wonderful in their attendance but we do want to see those faces that never get around—and we certainly want to get acquainted with you. The initiation ceremonies are very interesting and you miss one of the big benefits of the Society if you fail to attend. January's meetings were just as interesting as those of the preceding months. Mr. Samuel H. Moore, Director of Welfare and Pensions, Peoples Gas Light and Coke Company, struck the trend of modern ideas in his talk on "The Engineer from the Human Standpoint" at the meeting of January 8th. Mr. Harwood Frost, President of Brown Portable Conveyor Company, in his talk on Engineering Literature "How to Write and What to Read," January 22nd, explained some of the lacking qualifications of the Engineer.

On February 12th, 1:30 p. m., Mr. Benjamin Bills, Ph. D., will talk on "Face Value For Your Ideas." February 26th Mr. Harry Garber, of the Chicago Association of Commerce, will talk on "Foreign Trade Opportunities For the Engineer."

All of the subjects are always open to informal discussion during the meeting.



Office Building For Link Belt Company

Frank D. Chase, Inc.—Engineers

An advanced type of modern industrial office building has recently been completed for the Link Belt Company at 39th street and Princeton avenue, Chicago.

This building is a three-story and basement reinforced concrete flat-slab structure, approximately 63 ft. x 184 ft. in plan. The main elevation is faced with red velour brick in a full range of colors and is trimmed with concrete.

The basement contains men's and women's locker rooms, storage rooms, machine room and dark room. The first floor is used for office space and also contains a fully equipped cafeteria and kitchen with automatic refrigerating apparatus. The second floor is devoted to general office purposes, and contains conference rooms, private office and a sound-proofed stenographers' room. The third floor is used largely for a drafting room, and contains a fully equipped blue-print room with fire-proof vault.

First and second floors are covered with linoleum laid on wood and the third floor with maple. Large wooden double hung sash is used throughout and all windows are equipped with plate glass ventilators. All trim is oak and birch. The various floors are separated by means of hollow metal doors which are finished to match the adjoining trim. Toilet rooms are provided on all floors with terrazzo floors and marble partitions. Safety vaults, dumb waiters and sound-proof phone booths are also provided.

Heating of plant is a system of hot water forced circulation brought in underground tunnel from present power plant.

One of the features of this building is the trench system in each floor, consisting of a main trench down the center of the building and five laterals in each bay. These trenches contain all light wires, signal wires, automatic telephone and bell telephone connections and are designed to eliminate entirely the use of miscellaneous outlets or exposed wires for all purposes throughout the building, with exception of fan brackets and outlets which are provided on all columns. This arrangement provides an extremely flexible system.

The drafting room on the top floor is provided with a saw tooth having two rows of steel top hung sash operated. This room is equipped with C-2 Mazda illumination. The remarkable lighting conditions which are obtained in this room at all times during the day or night have occasioned much favorable comment.

Another feature of the building is the photographic dark room in the basement. This room was developed after consultation with leading photographic authorities and containes many features not found elsewhere.

This building was designed by Frank D. Chase, Inc., Engineers, Chicago. The E. W. Sproul Company were the contractors.

Mr. Charles Piesz, M. W. S. E., is President of the Link Belt Company.

Applied Technical Committees

Membership and activity in these Committees of the Western Society of Engineers are worth while.

They present opportunities for the study of engineering problems of great importance to the municipality; increase our acquaintance with those who are like minded and will result in a contribution to the public welfare.

Committees are now study Waterways; Terminals; Aviation and Public Affairs.

Reports and investigations will be presented to the entire Society in due time.

The Secretary will be glad to know of any member who wishes to contribute to this form of committee work.

Illinois Section A. S. C. E.

At the Annual Meeting, held January 13th, the name of association was changed as indicated above so as to conform to the rules adopted by the parent Society:

The officers are:
President—Mr. C. B. Burdick.
Vice President—Mr. A. J. Hammond.
Vice President—Mr. J. N. Hatch.
Secretary and Treasurer—Mr. W. D. Gerber.

Highway Engineering Conference

The Department of Civil Engineering of the University of Pennsylvania has organized for a Highway Conference to be held in Philadelphia, February 7th to 11th, 1921. This is in cooperation with the Bureau of Public Roads, Department of Agriculture and the State Highway Department of the State of Pennsylvania, Delaware, New Jersey and Maryland.

The program calls for half day sessions, at which will be presented the following subjects: Surveys; Plans and Drainage; Estimates and Earthwork; Maintenance; Economics and Design; Field Material Surveys and Bridges; Bituminous Construction; and Concrete and Brick Roads.

A Brief Course in Highway Engineering will precede the Conference, beginning January 24th and closing February 5th.

Prof. Milo S. Ketchum is in charge of this progressive educational enterprise.

American Road Builders' Association

The Eleventh American Good Roads Congress, the Twelfth National Good Roads Show and the Eighteenth Annual Convention of the American Road Builders' Association will be held at the Coliseum, Chicago, Illinois, February 9th, 10th, 11th and 12th, 1921.

The program of addresses, prepared papers and discussions is now in course of preparation for the eight sessions of the congress. Among the subjects already selected are the following:

"Our National Road Problems."

"The Relation of the Highway and Motor Transport Movement to Education."

"Highway Improvements in New England."

"Highway Transportation."

"Types of Pavements."

"The Local and National Importance of the Lee Highway."

"Subgrades."

"Recent Developments in Road Building."

"Highway Finance."

"Relation Between Highway Engineers and Contractors."

Announcement is made of the marriage of William B. Poland, M. W. S. E., to Miss Dorothy Hofflin at Paris, France, November 16, 1920. Mr. Poland was associated with Mr. Herbert Hoover in the work of the American Commission for Relief in France and Belgium. Miss Hofflin was also engaged in war relief work with the American Red Cross in France and Constantinople. After January 1st Mr. and Mrs. Poland will reside at 200 W. 59th street, New York City.

On and after January 15, 1921, the offices of John Mohr & Sons will be located at their South Chicago works, 96th street and the Calumet River, Chicago, the Chicago and South Chicago plants having been consolidated.

The appointment of Homer Niesz, M. W. S. E., as Manager of Industrial Relations, Commonwealth Edison Co., was announced by President Samuel Insull, M. W. S. E., in a circular letter addressed to each employe on Saturday, January 8, 1921.

PERSONALS

The Locomotive Superheater Company, with general offices 30 Church street, New York City ,announces that on January 1st, 1921, they opened their own Company Office at 382-388 Union Arcade Building, Pittsburgh, Pa.

Mr. John R. LeVally, formerly sales engineer with the Chicago Office of the Locomotive Superheater Company, has been appointed District Manager.

Mr. LeVally is a graduate of Armour Institute of Technology. He was associated for several years with M. Rumely Co., La Porte, Indiana, in assembling and testing tractors. Subsequently Mr. LeVally was construction and power engineer for Armour & Co.'s Chicago plant, and later was superintendent of construction and power plants for the Union Stock Yards & Transit Co., and the Produce Terminal Corp., at which time he had charge of design, purchasing and erection of several large power plants.

Mr. LeVally was for 18 months an officer in the U. S. Navy, serving on the Battleship Vermont and the U. S. Transport Huron.

He is associate member in both the American Society of Mechanical Engineers and the Western Society of Engineers.

Mr. Carl L. Linde, M. W. S. E. Architect and Engineer, left for a several months' trip to the Pacific coast, where he will supervise the construction of an eight-story apartment hotel, which when completed will be the largest in Portland, Oregon.

At a meeting of the Board of Direction, held January 17th, 1921, a committee was appointed to prepare a memorial for James J. Reynolds, consisting of Wm. Artingstall, Chairman, E. C. Shankland and E. R. Shnable.

A. W. Dilling, M. W. S. E., has been appointed Chief Engineer of the Sanitary District of Chicago.

Mr. S. T. Smetters, M. W. S. E., has been appointed Maintenance Engineer of the Sanitary District.

Mr. Smetters will have entire charge of the Maintenance of the main channel, bridges, pumping stations and water Power.

TERMINAL COMMITTEE

J. R. BIBBINS, Chairman

The Terminal Committee has recently considered and taken definite action in connection with the general plan of Indiana Harbor proposed by Col. Wm. V. Judson, District Engineer Officer, U. S. A., for the purpose of furthering arrangements, legislative and otherwise, for securing, against future need, the large area in the Wolf Lake District to be ultimately developed as the main rail-terminal of the Chicago District.

The matter has been considered by sub-committees of both the Terminals and Waterways Committees and appropriate resolutions jointly approved by both committees.

Thus the Western Society of Engineers, through its committees, has made prompt recognition of the work of Col. Judson in this particular with the object of giving him definite assistance and support in his efforts to crystalize public opinion and secure prompt action in this important movement. This matter will cure prompt action in this important movement. This matter will be reported more fully in a later issue of the Journal.

It is of interest to the members of the Society to note that Col. Judson has just been awarded by the President of the United States the Distinguished Service Medal in recognition of his services during the war period.

More Funds Needed For Fire Fighting

The cost of fire fighting by the United States Forest Service for the fiscal year ending June 30, 1920, as reported by Col. William B. Greeley, Forester, was approximately $800,000. The cost was somewhat increased by the high prices of supplies and the prevailing wage scale.

The appropriation for this important work is only $250,000 a year. As a result a deficiency appropriation must again be sought. It has been necessary to go to Congress for such appropriations in six out of the nine years that have passed since the fire fighting funds were cut from $1,150,000 for the fiscal year 1913 to $350,000 for 1913, with subsequent further reductions.

NEW MEMBERS

At the meeting of the Board of Direction, held December 20th. 1920, the following new members were elected:

129 Edgar M. Rhyner, 196 Willoughby Ave., Brooklyn, N. Y. .... Student
130 Chas. W. Pick, 3845 Minticello Ave., Chicago .... Member
148 Benjamin F. Morrison, 6205 Ellis Ave., Chicago .... Student
156 Arthur R. Eitzen, 7128 Ridgeland Ave., Chicago .... Member
158 Garfield J. Stell, 935 N. Karlov Ave., Chicago .... Member
159 Chas. K. Morgan, 1724 Summerdale Ave., Chicago .... Member
160 M. E. Webster, 113 N. Perry, Peoria, Ill .... Associate
161 W. B. Reichard, 851 Galt Ave., Chicago .... Associate
163 J. A. Scanlan, 447 Fullerton Ave., Chicago .... Member
165 James M. McFarland, Lewis Institute, Chicago .... Junior
115 Melvin F. Webster, 6323 Drexel Ave., Chicago .... Member
126 Ferdinand M. Moore, 6056 Prairie Ave., Chicago .... Affiliated
146 H. O. Hague, 119 E. 48th St., Chicago .... Associate
154 Robert E. Kinkead, 4210 Washington Blvd., Chicago .... Member
162 John W. Horsfield, 5234 W. Congress St., Chicago .... Associate
164 Elmer E. Christenson, 5904 Midway Park, Chicago .... Associate
137 H. A. Brassert, 943 Peoples Gas Bldg., Chicago .... Member

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APPLICATIONS RECEIVED

Applications for membership were received by the Board of Direction since its meeting held December 20th, 1920, as follows:

179 Matthew Dwyer .... 6015 Harper Ave., Chicago, Illinois
180 Wm. C. Larson .... 1409 Manhattan Bldg., Chicago
181 C. G. Corduan .... 5413 Windsor Ave., Chicago
182 S. H. Ingberg .... Garrett Park, Md. (Transfer)
183 Walter Painter .... 211 N. Grove Ave., Oak Park, Ill. (Transfer)
184 Victor Leroy Fixen .... 1105 Mallers Bldg., Chicago

EMPLOYMENT SERVICE

Do you need assistants?

Do you want a position?

Do you feel that you have men in your employ that are needed more in some other position?

Do you wish a change or advancement? The service we render is to bring men together for their mutual benefit. In order to do this, we offer free of charge, this Employment Service. Will you use it?

POSITIONS WANTED

B-820: POSITION WANTED, GENERAL superintendent of construction, by man of thirty years' experience in nearly every phase of engineering here and abroad. Best of reference.

B-821: POSITION WANTED AS MECHANICAL draftsman; experience four years.

B-822: POSITION WANTED AS JUNIOR Industrial Engineer. Experienced in factory management and time study.

B-824: POSITION WANTED AS LEVELMAN or rodman; four years' experience.

B-825: POSITION WANTED AS DRAFTSMAN. Experience 5 years grain elevator work. Structural and mechanical.

B-826: POSITION WANTED AS RODMAN. Salary $140.00.

B-827: POSITION WANTED AS STRUCTURAL engineer; experience 14 years designing fixed and movable bridges, and bridge machinery, also checking shop and and structural details.

B-828: POSITION WANTED AS SUPERINTENDENT or Production Engineer. Experience in design or construction of special machinery and industrial work.

B-829: POSITION WANTED AS SALES Engineer in steel products. Experience six years.

B-830: POSITIONWANTED AS INSTRUMENTMAN or draftsman. Experience two yrs. Construction and valuation departments, R. R.

POSITIONS WANTED

B:833: POSITION WANTED AS CONCRETE designer. Experience 7 years as re-inforced concrete detailer, designer and checker.

B-834: POSITION WANTED AS STRUCTURAL designer or detailer by graduate C. E. Armour. Three years' outside experience.

B-835: POSITION WANTER AS SURVEYOR or rodman. Experience five years.

B-836: POSITION WANTED AS CIVIL ENgineer, instrumentman or estimator. Will also consider position in mining field.

B-837: POSITION WANTED ON INDUSTRIAL layout or building equipment, or industrial appraiser.

B-838: POSITION WANTED AS ASSISTANT superintendent or sales engineer. Building construction or building materials.

B-839: POSITION WANTED AS DRAFTSMAN, detailer on concrete. Experience three years.

B840: POSITION WANTED AS MACHINE and tool designer by graduate M. E. Experienced, covers both technical and practical shop work and maintenance.

B-841: POSITION WANTED AS ARCHITECTURAL draftsman. Experience 8 years, all kinds building work.

B-842: POSITION WANTED BY GRADUATE C. E. Experience 20 years, structural, steel, concrete, water supply, sewerage.

POSITIONS WANTED

B-831: POSITION WANTER AS ASSISTANT to Chief Engineer, Printing Plant or mechanical designer on general machinery. Experience 18 years.

B-843: POSITION WANTED AS STORE front draftsman, in construction or maintenance, drafting, good estimator, shop order and follow-up man.

B-844: POSITION WANTED IN SOUTHERN California, railroad work, harbor or general construction, by graduate C. E. Six years' experience, having served two years additional in Corps of Civil Engineers, U. S. N.

B-845: POSITION WANTED AS OPERATING and constructural engineer in charge of electrical apparatus and operation of same. Experience 14 years.

B-846: POSITION WANTED AS ARCHITECTURAL draftsman or estimator. Experience four years.

B-847: POSITION WANTED AS DESIGNER of industrial buildings, bridges, oil refineries, steel or concrete, by graduate C. E. Experience three years.

B-848: POSITION WANTED AS DRAFTSMAN, preferably in automotive work. Experience five years.

B-849: POSITION WANTER AS ASSISTANT electrical engineer or electrical draftsman. Experience four years. Would consider position in South America.

B-850: POSITION WANTED IN REINFORCED concrete designing and construction. Experience four years.

POSITIONS WANTED

B-851: POSITION WANTED BY ARMOUR student in structural engineering; prefers part time work afternoons or evenings in construction or office work for increasing practical knowledge of course.

B-852: POSITION WANTED ALONG C. E. lines by young man having two years' R. R. experience; will go outside Chicago if necessary.

B-853: POSITION WANTED IN CIVIL ENGINEERING. Two and one-half years at Lewis Institute. By young man, single; prefers work in Chicago.

B-854: POSITION WANTED AS STRUCTUARL steel designer or detailer. Experience four years.

B-855: POSITION WANTED AS BRIDGE designer, involving indeterminate stresses, structures of any kind, designing that involves mathematical investigation. Experience 10 years, all classes of structures. Graduate and post-graduate Course of Structural Engineering, University of Minnesota.

B-856: POSITION WANTED AS CONCRETE detailer. Experience four years.

B:857: POSITION WANTED AS CHEMICAL engineer; research or delevolpment chemist. Experience supervisor of construction, potash plant, also with dyestuffs.

B-858: POSITION WANTED AS MECHANICAL engineer, draftsman or industrial sales engineer. Experience three years former and one year latter position.

SECRETARIES OF ENGINEERING SOCIETIES
CHICAGO, ILL.

Organization	Secretary	Address	Telephone
Am. Soc. C. E. (Illinois Section)	W. D. Gerber,	913 Chamber of Com.	Franklin 2243
A. S. M. E. (Chi. Section)	J. D. Cunningham,	2240 Diversey Blvd.	Armitage 254
A. I. E. E. (Chicago Section)	M. M. Fowler,	925 Monadnock Blk.	Har. 9800
A. I. M. E.	F. G. Fabian,	1025 Peoples' Gas Bldg.	Har. 470
Am. Ry. Engrg. Assn.	E. H. Fritch,	431 S. Dearborn St.	Har. 1069
Am. Chem. Soc.	S. L. Redman,	460 E. Ohio St.	Sup. 7920
Am. Soc. Htg. & Vent. Engrs.	Benj. Nelson,	1301 Monadnock Blk.	Wab. 9038
Am. Soc. Refrig. Engr.	Thos. McKee,	431 S. Dearborn St.	Har. 5643
Am. Steel Treaters Soc.	H. Blumberg,	Ill. Steel Co., S. Chgo.	S. Ch. 4000
Am. Inst. Architects	Ed H. Clark,	8 E. Huron St.	Sup. 1461
Assn. I. & S. Elec. Engrs.	W. H. Williams,	1501 Monadnock Blk.	Har. 1190
Am. Assn. of Engrs.	W. H. Dean,	29 S. LaSalle St.	Cent. 73
Am. Welding Soc.	L. B. Mackenzie,	608 S. Dearborn St.	Wab. 7134
Ill. Soc. of Architects	Ralph C. Harris,	192 N. State St.	Rand. 2409
Ill. Soc. of Engrs.	E. E. R. Tratman,	1570 Old Colony Bldg.	Har. 2196
Illuminating Eng. Soc.	Jas. J. Kirk,	72 W. Adams St.	Rand. 1280
Natl. Assn. Prac. Ref. Engrs. (Chicago Subordinate)	E. H. Fox,	5707 W. Lake St.	Austin 1303
Soc. Automotive Engrs. (Mid-West Section)	L. S. Sheldrick,	910 S. Michigan Ave.	Har. 1455
Soc. Industrial Engrs.	Geo. C. Dent,	327 S. LaSalle St.	Wab. 3291
Struct. Engrs. Assn.	John P. Cowing,	30 N. LaSalle St.	Frank. 778
Swedish Eng. Soc. of Chicago	C. H. Mayer,	404 Monroe Bldg.	Rand. 6120
Western Society of Engineers	E. S. Nethercut,	1736 Monadnock Blk.	Har. 945

CURRENT NEWS SECTION

JOURNAL OF THE
WESTERN SOCIETY of ENGINEERS

Volume XXVI | MARCH 1921 | Number 3

Nomination of Officers of the Society

The Nominating Committee, consisting of Messrs. G. R. Brandon, C. C. Brooks, H. G. Clark, F. K. Copeland, John Dailey, M. M. Fowler and J. E. Love, has been appointed and in accordance with the provisions of the Constitution, at the meeting held the 15th, organized by electing Mr. C. C. Brooks chairman and Mr. John Dailey Secretary. This Committee is charged with the duty of nominating officers for the ensuing year as follows:

President.
First Vice-President.
Second Vice-President.
Third Vice-President.
Treasurer.
Trustee for three years.

The Constitution provides that the Nominating Committee shall report to the Board of Direction at their regular meeting in March, which will be held March 21st. Nominations so reported shall be known as the Regular Ticket.

Additional nominations for any office may be made by petition, provided such petition is accompanied by an acceptance of the nomination signed by the nominee, if filed with the Secretary of the Society before the 20th of April, and further provided that each petition shall be signed by at least twenty Corporate Members. Nominations made in accordance with this Section shall be known as the Ticket by Petition. The Constitution provides ample opportunity for members to exercise fully their judgment in securing officers for the Society.

The Nominating Committee will be glad to receive suggestions from the membership.

Officers of the Sections

The rules of the Sections provide that the officers for the ensuing year shall be nominated at the next to the last regular meeting of the Section and shall be elected at the last regular meeting of the Section during each year. Nominations will therefore be in order at the following dates:

Mechanical Engineering Section—February 21st.

Gas Engineering Section—March 9th.

Hydraulic, Sanitary and Municipal Engineering Section—March 21st.

Telephone, Telegraph and Radio Engineering Section—April 7th.

Bridge and Structural Engineering Section—April 11th.

Railway Engineering Section—April 21st.

Electrical Engineering Section—April 25th.

In each instance there is to be nominated a Chairman, a Vice-Chairman and one Director for a three-year term. All officers and Directors shall be Corporate Members of the Western Society of Engineers. The retiring Chairman and Vice-Chairman shall not be immediately eligible to re-election to their respective offices. The Chairmen of the various Sections are members of the Board of Direction.

AVIATION COMMITTEE

JOHN F. HAYFORD, Chairman

The Aviation Committee have made preliminary arrangements for a trip to one of the Chicago flying fields in the Spring when the weather becomes suitable.

GEORGE HOLT LUKES

George Holt Lukes, A. W. S. E., general superintendent of the Public Service Company of Northern Illinois, died February 18th, 1920, at Ravenswood Hospital after a week's illness. Mr. Lukes was 51 years old. He was unmarried, and made his home at the Evanston University Club, where the funeral services were held February 21st. Burial was at Racine, Wisconsin.

Mr. Lukes was elected to membership in June, 1904.

American Society of Agricultural Engineers

The American Society of Agricultural Engineers announces the election of officers for 1921 as follows:

President—A. E. White.

First Vice-President—W. G. Kaiser.

Second Vice-President—E. R. Jones.

Secretary-Treasurer—Frank P. Hanson.

The Executive Council for 1921 consists of: I. W. Dickerson, F. N. G. Kranich, Raymond Olney, F. A. Wirt, J. B. Davidson.

At the meeting of the Board of Direction held February 21st, the resignation of Mr. J. H. Libberton as Trustee of the Society was accepted.

Mr. J. W. Lowell was appointed to succeed Mr. Libberton.

NOONDAY LUNCHEON COMMITTEE

Engineering interest in the railroad problem was shown conclusively at the Noonday Luncheon Meeting, held February 11th at the Morrison Hotel. An overflow crowd of 500 heard President William B. Storey, of the Atchison, Topeka & Santa Fe Railway, discuss "The Railway Problem of Today."

Mr. Storey referred to events that have led up to the present conditions, and pointed out the questions that are uppermost at the present time. A complete report of his talk will be found on another page of the Journal.

The popularity of the Noonday Luncheons is so pronounced that members are suggesting more frequent luncheons. The committee has decided, however, that for the present it would be best to continue with luncheons once a month.

Effort is being made to secure one of the most prominent men in Chicago of national reputation for the Noonday Luncheon meeting on Friday, March 11. As this is being written, his acceptance is not yet definite, but the announcement will be made as soon as possible. In case we are not able to secure this national figure, we expect to have a talk of unusual importance by a well-known educator.

Arrangements have already been made for prominent speakers for Friday, April 8, and Friday, May 13.

The Monthly Noonday Luncheon habit is an excellent habit to cultivate.

EXCURSION COMMITTEE
CASS KENNICOTT, Chairman

A meeting of the Excursion Committee was held at the Society rooms February 17. Tentative arrangements were made to hold excursions to the following points :

March—Morris & Company, Union Stock Yards, Chicago.

April—Milwaukee, Wis.

May—Urbana, Ill.

June—South Bend, Ind.

The exact dates and detailed information concerning the trips will be announced later.

Announcement is made of the removal of the General Office, Morgan-Gardner Electric Company to their plant, 2640 Shields Avenue, Chicago.

Book Reviews

Drainage Engineering.
By
Daniel William Murphy.

In the preface the author states that his purpose in writing this book has been to present a general treatise on the drainage problem and to put into brief but comprehensive form the principles involved in the design and construction of drainage works.

To the engineer interested in drainage of irrigated lands, this book has much to commend it. The theory of drainage of agricultural lands in its relation to soil and hydrographic conditions and the engineering principles involved in the design of drainage works are ably presented.

Descriptions with illustrations of various types of excavating machinery and specifications and methods of testing for drain tile are included. One chapter is devoted to irrigation in its relation to ground water supply. Less attention is given to the drainage of swamp and overflowed lands.

The practical value of the volume would be enhanced by the addition of a few examples of important drainage works in the United States and the inclusion of additional tables and diagrams. The number and the quality of the photographic illustrations is a very commendable feature.

L. C. Craig, M. W. S. E.

Engineering for Land Drainage
By
Charles Gleason Elliott.

"Engineering for Land Drainage," by C. G. Elliott, is one of the best known books in this branch of engineering. It does not present a complete discussion of the theory of drainage in its relation to air, soil and vegetation and other factors, neither does it contain a complete history of the development of land drainage.

This volume is essentially a text book containing some material of an elementary nature. It presents briefly the fundamental principles governing the successful design of drainage works and also formulae, tables and diagrams of value both to students and to engineers actually engaged in drainage work.

The author has made a number of revisions and has added some material in this, the third edition. The section dealing with tile drains has been rewritten and matter has been added upon drainage by pumps and drainage of irrigated lands.

A new diagram to facilitate the application of Kutter's formula in the design of ditches and canals is an added feature of value. The diagram is for Kutter's formula n=.030, the proper value to use in the design of most drainage ditches.

By its use, when bottom width, depth and gradient are known, the discharge of ditches and canals with side shapes 1 to 1 can be read directly, thus making unnecessary several computations.

Much material could be added to this book in order to increase its usefulness. One or two illustrations of large drainage projects in the United States would be of value. The illustration of a typical drainage pumping plant does not give the student a clear idea of a modern plant. The data on surveying and map making is incomplete.

The protection of levees and banks of streams from erosion has come to be of such an important part of drainage engineering that more material on this subject would be useful. A few photographs would add to the interest and might have justified the additional cost.

Taken as a whole, the book is of value and will prove to be of use in the office of any drainage engineer.

L. C. Craig, M. W. S. E.

Lewis Institute Branch—Western Society of Engineers

The following officers of the Lewis Institute Branch of the Western Society of Engineers have recently been elected:

President, Lestern N. Weber; vice-president, H. Ralph Heitzman; secretary, Henry C. Van Dyke; treasurer, Wm. F. Drews; sergeant-at-arms, I. Singer.

J. H. Libberton Resigns

On January 1st the Society lost the activities of J. H. Libberton, who has accepted a position with the General Chemical Company, at 25 Broad Street, New York City.

Mr. Libberton resigned as Manager of the Service Bureau of the Universal Portland Cement Company after thirteen years with that company.

In the matters of the Western Society of Engineers, Mr. Libberton has always taken a most active interest. During the past year Mr. Libberton has been a Trustee of the Society, and Chairman of the Noon-day Luncheon Committee. The success of these luncheons has been due largely to his organizing ability.

We are sorry to lose him from Chicago, but he has the good wishes of every one who knows him.

YOUNG MEN'S FORUM
BENJAMIN B. SHAPIRO, Chairman.

On Saturday afternoon, February 12th, Mr. Benjamin Bills, Assistant Secretary of the Continental and Commercial National Bank, gave an interesting informal talk before the Young Men's Forum. In developing his subject, "Face Value for Your Ideas," Mr. Bills emphasized the necessity of logical and concise expression of the idea and explained two successful metohds applicable to extemporaneous speaking. This was Mr. Bills' second appearance before the Forum and he has been so well received that it is hoped he will accept the invitation to again talk to the Young Men of the Society.

Incidentally it might be noted that in the well-attended meeting before which Mr. Bills spoke, were several of the older men of the Society, who greatly appreciated the talk. Little by little the members are learning that the meetings of the Young Men's Forum are as interesting and as instructive as any of the meetings of the Society.

Sounds Like an Engineer

THE SPIRIT OF 1921.

"Somebody said that it couldn't be done,
But he with a chuckle replied,
That "maybe it couldn't, but he would be one
Who wouldn't say so till he tried.

So he buckled right in with a trace of a grin
On his face. If he worried, he hid it—
He started to sing as he tackled the thing
That couldn't be done—and he did it.

Somebody scoffed: "Oh, you'll never do that—
At least no one ever has done it;"
But he took off his coat and took off his hat,
And the first thing we knew he begun it.

With a lift of his chin and a bit of a grin,
Without any doubting or quiddit;
He started to sing as he tackled the thing
That couldn't be done—and he'd did it.

There are thousands to tell you it cannot be done,
There are thousands to prophesy failure;
There are thousands to point out to you, one by one,
The dangers that wait to assail you.

But just buckle in with a bit of a grin,
Then take off your coat and go to it;
Just start in to sing as you tackle the thing
That "cannot be done"—and you'll do it.

—*Red Cross Bulletin.*

Personals

Mr. J. A. Lindstrand, who for the past five years has been engaged as architect for the Bureau of Valuation, Interstate Commerce Commission, announces that he has severed his connection with the United States Government and has opened offices for the general practice of architecture, at Suite 523 Bush Temple, 800 North Clark street, Chicago. His services are available in connection with designing, consulting and valuation work of railroad structures. Mr. Lindstrand's long years of experience with the C. B. & Q. Ry. and as Architect of the C. M. & St. P. Ry. enable him to render expert service to carriers not having their own architectural staff, in the designing and constructing of Station Buildings, Coal-Handling Plants, Ice Houses and General Railroad Buildings.

Mr. Wm. R. Cadwell, formerly with A. S. Schulman and the C. & N. W. Ry. Co., has joined the staff of the Norwood-Noonan Company, Contracting Electrical and Mechanical Engineers, Chicago, and will handle industrial and railway electrical installations.

The many friends of C. W. PenDell will be glad to learn of his improved condition, following a serious operation which confined him to the hospital for six weeks. He is now at home and we hope will soon be able to return to his duties in good health.

Notes.

Large amounts of lumber are used in the oil fields of Texas and other oil-producing States. The average well requires about 12,000 feet. Besides using the lumber for derricks, platforms, sheds and auxiliary buildings, it is often necessary because of the location of wells, to build many bridges and trestles. Some of the operators dismantle the derricks and buildings after the wells are exhausted but others abandon them entirely. In timbered areas operators have found it profitable to start portable mills.

Sawdust as a waste product is a thing of the past, for it now serves many purposes and has an ever increasing commercial value. Mixed with clay it makes good tiles and bricks and combined with concrete a good flooring material is obtained. It also finds a place in the dye industry for coloring purposes.

A gas excellent both for lighting and heating purposes, can be made from sawdust. It is believed that, particularly in the neighborhood of sawmills, the gas could be produced so cheaply as to be supplied for a few cents per thousand feet.

DONALD BOWMAN

After an illness of several months, Donald Bowman, Engineer of Apparatus and Materials, Commonwealth Edison Company, died at the home of his sister, in Mitchell, South Dakota, on Tuesday, January 18th. He was buried at Marion, Indiana.

Mr. Bowman entered the service of the Commonwealth Edison Company in June, 1907, and with the exception of about a year, which was taken in completing his course at the Massachusetts Institute of Technology, he remained in their employ until October of last year.

Mr. Bowman was a member of the A. I. E. E., Electric Club, Edison Club and a member of the Western Society of Engineers since January 5th, 1920.

ROBERT A. HOLBROOK

Robert A. Holbrook, M. W. S. E,. of Chicago Heights, Illinois, died February 11, 1921, at the age of thirty-six at Los Angeles, California, where he had gone in an endeavor to recover his health which had been failing for the past two years. Funeral services were conducted by the Chicago Heights Commandary, K. T., February 16th, at Chicago Heights Methodist Church, and interment was at Covington, Ohio.

In addition to a widow Mr. Holbrook left two small daughters and a mother to mourn his departure.

Mr. Holbrook graduated from the University of Michigan in 1906 and shortly afterward became affiliated with the Victor Chemical Works. In 1912 he became Chief Chemist and had under his particular direction all research work and much of the development work carried on by the company. He was ingenius, practical and resourceful to a high degree.

Mr. Holbrook was very much interested in civic matters and held positions of importance in the Chicago Heights community, where he was very highly regarded as a man and citizen. He was a member of the Masonic Bodies, Chicago Heights Country Club, Chicago Heights Industrial Club, City Club of Chicago, Western Society of Engineers and American Chemical Society.

Experts

Engineers who from time indulge in expert testimony will be interested in the remarks on the subject by Senator Williams, of Mississippi. He recently expressed the following opinion:

"In this world of ours 'knowledge comes, but wisdom lingers,' and the trouble with men as a rule, in my opinion, is that they are always going around hunting so-called 'expert' advice. The expert has knowledge, but almost never has wisdom."

Noon-Day Luncheon

In making the arrangements for service of the Noon-Day Luncheon on Friday there has been included a provision that those who would prefer fish rather than a meat service may be served by requesting such service from the waiter. It is sincerely hoped that those of our members who should desire to substitute will take notice. There is no extra charge involved.

At the Luncheon held Friday, February 11th, among the five hundred present was a table of young ladies from the Engineering Department of the Santa Fe Railroad. We shall be very glad to have at our Luncheons the ladies connected with the various engineering offices.

Public Affairs Committee

The Western Society of Engineers has twenty-three standing committees with a total personnel of 179 of its members, the largest and the one probably having the widest scope is the Public Affairs Committee, Mr. Andrews Allen, Chairman. They meet every Monday noon at the Chicago Engineers' Club of Chicago.

Because of the variety of subjects covered it was necessary to make sub-committees, each having a chairman. These sub-committees are:

Constitutional Convention.—J. L. Jacobs, Chairman; F. H. Cenfield, J. W. Alvord, R. F. Schuchardt, R. E. Schmidt, B. D. Barker, W. D. Gerber.

City Zoning.—Paul Green, Chairman; R. E. Schmidt, Albert P. Allen, Robert Knight, C. B. Ball, C. L. Mohler, G. W. Carr.

Streets and Highways.—M. L. Greeley, Chairman, W. G. Evans, G. A. Quinlan, Frank Windes, J. A. Dailey, G. W. Tillson.

Engineering Employment.—S. I. Stocking, C. C. Brooks.

Traffic and Transportation.—H. H. Easterly, Chairman; R. L. Kelker, C. L. Mohler, D. J. Brumley, J. V. Sullivan.

Smoke Abatement.—Joseph Harrington, Chairman.

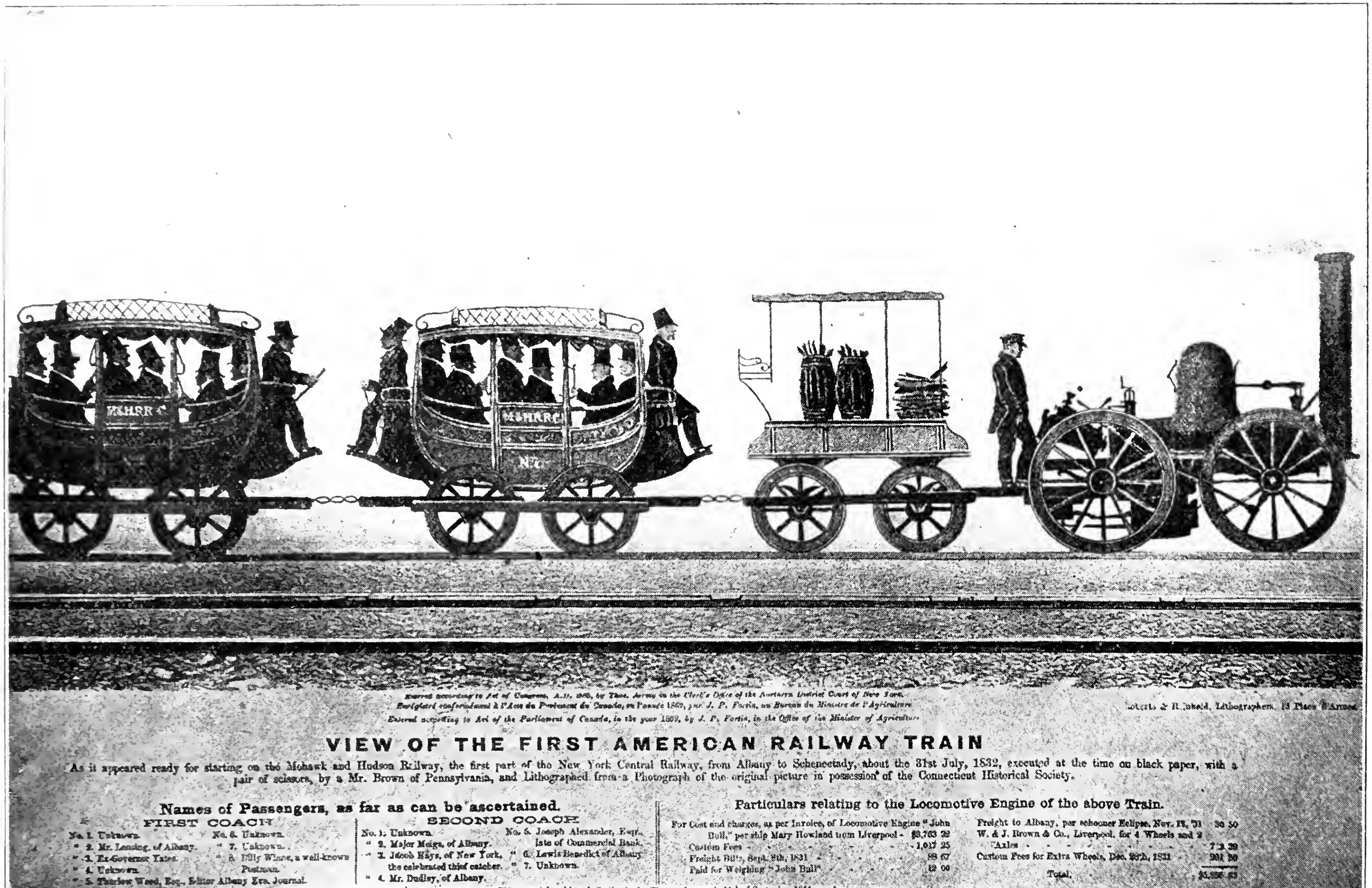
City Bridges—John P. Cowing, Chairman; J. H. Prior, H. C. Lothholtz.

Public Utilities.—Albert P. Allen, Chairman.

Parks and Playgrounds.—W. G. Evans, Chairman.

Cantonment Construction.—Robert Knight, Chairman; T. Frank Quilty.

Public Works.—J. H. Prior, Chairman; H. W. Evans, George C. D. Lenth.


VIEW OF THE FIRST AMERICAN RAILWAY TRAIN
As it appeared ready for starting on the Mohawk and Hudson Railway, the first part of the New York Central Railway, from Albany to Schenectady, about the 31st July, 1832, executed at the time on black paper, with a pair of scissors, by a Mr. Brown of Pennsylvania, and Lithographed from a Photograph of the original picture in possession of the Connecticut Historical Society.
Names of Passengers, as far as can be ascertained.
FIRST COACH
No. 1. Unknown.
" 2. Mr. Lansing, of Albany.
" 3. Ex-Governor Yates.
" 4. Unknown.
" 5. Thurlow Weed, Esq., Editor Albany Eve. Journal.
No. 6. Unknown.
" 7. Unknown.
" 8. Billy Winne, a well-known Postman.
SECOND COACH
No. 1. Unknown.
" 2. Major Meigs, of Albany.
" 3. Jacob Hays, of New York, the celebrated thief catcher.
" 4. Mr. Dudley, of Albany.
No. 5. Joseph Alexander, Esq., late of Commercial Bank.
" 6. Lewis Benedict of Albany.
" 7. Unknown.
Particulars relating to the Locomotive Engine of the above Train.
For Cost and charges, as per Invoice, of Locomotive Engine "John Bull," per ship Mary Howland from Liverpool - $3,763 22
Custom Fees - 1,017 25
Freight Bills, Sept. 8th, 1831
Paid for Weighing "John Bull" 12 00
Freight to Albany, per schooner Eclipse
W. & J. Brown & Co., Liverpool, for 4 Wheels and 2 Axles
Custom Fees for Extra Wheels
Total

Acknowledgment

At the joint meeting of the Railway Engineering Section, Western Society of Engineers, and the Chicago Section, American Institute of Electrical Engineers, held Thursday evening, January 20th, 1921, Mr. Ulysses S. Rogers, M. W. S. E., presented to the Society a large framed photograph of one of the first American railroad trains. A reproduction of the picture is shown on the opposite page.

This train operated over the Mohawk & Hudson Railway, the first part of the New York Central Railroad between Albany and Schenectady, making its initial trip on July 31, 1832. It consisted of a locomotive, "John Bull," tender and two passenger coaches and ran on strap rails.

The "John Bull" was built by W. and J. Brown & Co., at Liverpool, England, and brought to this country. It was altered somewhat in later years but made a splendid record during its time.

It is interesting to note the following data:

For cost and charges, as per invoice, of Locomotive Engine "John Bull" per ship Mary Howland from Liverpool	$3,763.22
Custom fees	1,017.25
Freight bills, Sept. 8, 1831	88.67
Paid for weighing "John Bull"	12.00
Freight to Albany, per schooner Eclipse, Nov. 12, 1831	30.50
W. and J. Brown & Co., for four wheels and two axles	742.39
Customs fees for extra wheels, Dec. 28, 1831	201.50
Total	$5,855.53

European Relief Council

The response which our members have made to the European Relief Council has been very gratifying. The activities of this Society were not called into this work until after it had progressed to a considerable extent and for this reason a large number of our members contributed direct, or through their other trade or local relations.

At the Noon-day Luncheon held January 14th, $648.00 was pledged and since this time subscriptions which have passed through this office amount to $709.00, making a total of $1,357.00. This response has been generous and is greatly appreciated. The following letter has been received in appreciation of the work of the members of this Society:

"My Dear Mr. Nethercut:

"To date our fund totals $1,014,725.00, and some money is coming in daily.

"Part of the clerical force will remain a few days longer to take care of all belated contributions.

"While 'Thanks" in work of this kind are not expected, we must, however, before 'discharging' ourselves and 'mustering out' our loyal band of co-workers, express to you our deepest appreciation for the helpful stimulation your assistance has been, without which it would not have been possible to have accumulated this gratifying total of collections.

"It has been a great pleasure to have worked with you in this 'life saving' cause, and we are all grateful in having been able to help.

"Sincerely yours

"A. A. Carpenter,
"Chairman Chicago Committee.
"Charles Rubens,
"Chairman Trades and Profession Com.
"R. Douglas Stuart,
"Vice Chairman Trades and Profession Committee."

Lewis Institute Branch Excursion to Western Electric Company

The Lewis Chapter of the Western Society of Engineers visited the Western Electric Company's plant on Tuesday, February 8th. The party arrived at the plant at nine-thirty. The cable plant was first visited. Here some of the following processes in the manufacture of telephone cables were seen:

The insulating of copper wire with paper.

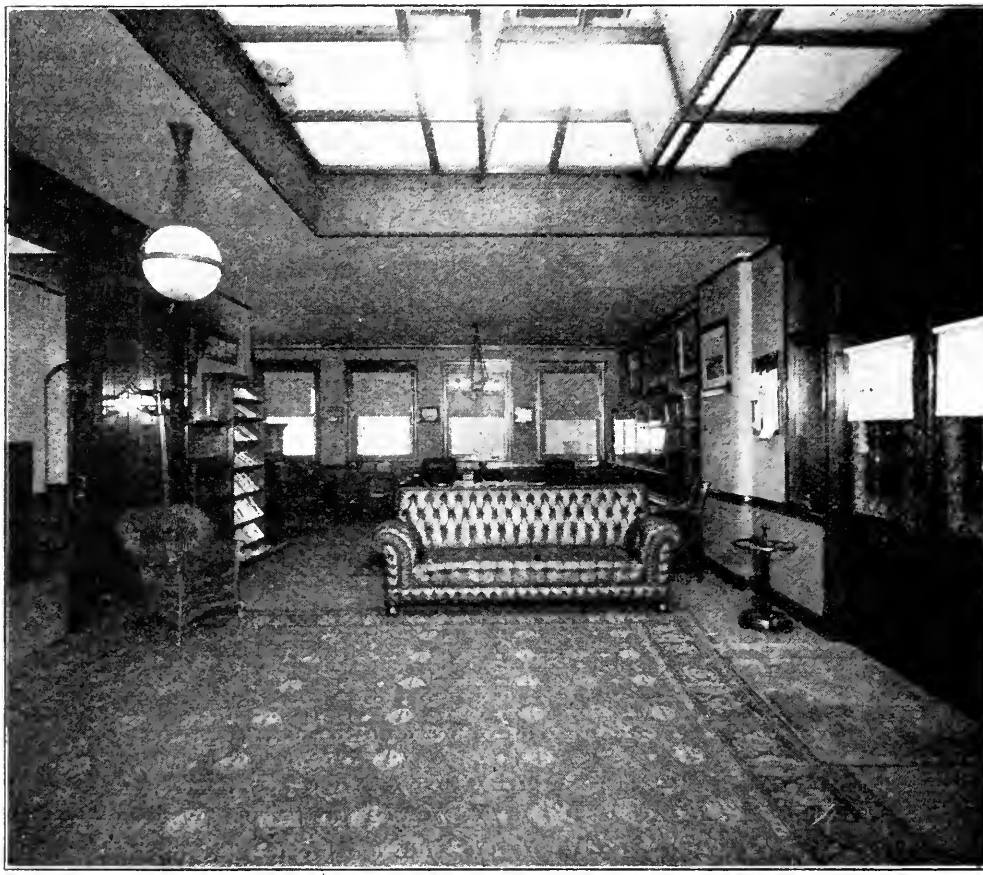
The twisting together of a number of these paper covered wires into a cable.

The covering of the cable with a coating of lead.

The protecting of cables for submarine use.

Some of the other divisions visited were the wood shops where the wooden parts for switchboards and telephones are made; the coil winding departments where the many different types of coils are wound; the chemical department; Western Electric Company's private telephone exchange; several testing departments; experimental engineering department; switchboard assembly room where the new machine switching switchboards are being set up; several machine sections, including several automatic screw machine sections; and the large power plant. Several places such as the drafting departments and the foundry were not visited because of lack of time. The party left the plant at about three-thirty. The trip was certainly a very interesting and instructive one.

Henry VanDyke, Secretary.



LIBRARY SERVICE

I. F. STERN, Chairman, Library Committee

The Library of the Western Society of Engineers is now being utilized to a greater extent than ever before in its history. The average daily attendance has now risen to twenty-five, making a monthly total for January of six hundred and forty-six.

February is showing an increase in attendance and for several days this month there have been over fifty visitors making use of the Library facilities.

The Library Service is now being appreciated and many flattering comments are being made on the efficient help extended to those seeking information on various subjects.

Among the subjects upon which information has been asked are: Tunneling, deep waterways, cranes, fluorspar, steel castings, dust removal, harbors, docks, cement gun, tests on brick, earth vibration, gears, dome construction, paving, motor trucks, etc., etc.

The following volumes have been added to the Library:

Bacon, R. F., and Hamor, W. A.—American Petroleum Industry.

Fuller C. E., and Johnston, S. B.—Applied Mechanics.

Hobart, J. F.—Millwrighting.

Rodenhauser, W., and others—Electric Furnaces in the Iron and Steel Industry.

Creager, W. P.—Engineering for Masonry Dams.

Wehrle, George—American Gas Works Practice.

Prof. D. W. Mead has added the new edition of his book, "Contracts, Specifications and Engineering Relations," to the Library.

Mr. W. S. Lacher has made a gift to the Library of the following volumes:

Melan, J.—Plain and Reinforced Concrete Arches.

Howe, M. A.—Masonry.

Wagner, J. B.—Seasoning of Wood.

Howe, M. A.—Symmetrical Masonry Arches.

Ketchum, M. S.—Walls, Bins and Grain Elevators.

McWane, R. C.—Pipe and the Public Welfare.

Mr. E. S. Nethercut placed in the Library:

VanVelzer and Slichter—University Algebra.

VanVelzer and Shutts—Plain and Solid Geometry.

VanVelzer and Slichter—School Algebra.

Wentworth—New School Algebra.

The "Handbook of Building Construction," by G. A. Hool and N. C. Johnson is now available in the Library. A review will be published at a later date.

Examination for City Engineer

Because of the importance of the position of City Engineer in the City of Chicago, the Western Society of Engineers made certain recommendations to the Civil Service Commission and transmitted the following letter:

"CHICAGO, Jan. 21st, 1921.

"To the Honorable,
"The Civil Service Commission,
"City of Chicago,
"City Hall, Chicago, Illinois.

"Gentlemen: On the recommendation of our Public Affairs Committee, the Board of Direction of our Society, realizing the importance of the position of City Engineer, and also realizing your desire to have wide competition in order to obtain the best fitted engineering executive for the position, desires to offer to the Chicago Civil Service Commission its co-operation and assistance in the forthcoming examination concerning which we have recently been advised.

"We believe that this examination is probably as important as any affecting the welfare of the city at large as the results of the examination will determine the administration, planning, construction, operation and maintenance of the municipal water works, bridges and the other important engineering work of the City of Chicago.

"Because of the importance of the position and the desirability of getting the best and widest competition of men who have had the necessary engineering and executive training and experience, it seems clear that such an examination should be comprehensive and yet practical and should be conducted under the general supervision of a Board of Examiners made up of representative engineering and technical executives.

"Your Honorable Commission, as well as other Civil Service Commissions in this country, has already set a precedent in the conduct of examinations for similar high grade executive and technical positions by having special examining boards undertake and carry through the complete work necessary to determine the most fit of those who complete for such positions.

"The Western Society of Engineers, through its Journal and other means, will be glad to give wide publicity to this examination and further, the Society will be glad to recommend names of engineers and technical executives of established standing and reputation to act as an Examining Board for your Commission in the complete conduct of this examination.

"We note by the present legal advertisement that the examination for the position of City Engineer is to be an original entrance, open to citizens of the City of Chicago. It is our understanding that under the civil service law and rules it is required that a promotional examination be held wherever practicable, where there are at least two employes in the municipal service whose duties are of the character and grade to properly fit them for the performance of the duties of the next higher grade. In order that no question arise in the future regarding the legality of the examination, may we suggest that in readvertising this examination, a promotional examination for the position of City Engineer be held at the same time and place so that any employes in the city service who may be declared eligible by the Commission may have the opportunity to compete. We further recommend the widest competition for this examination and that the original entrance examination be not confined to citizens of the City of Chicago but be open to competition between citizens as widely as practical under the law, waiving local residence.

"It is our opinion that in order to insure the best results from this examination it would be advisable to give sufficient time for the appointment of an Examining Board, for wide publicity, and for the preparation of the examination.

"Respectfully yours,
"EDGAR S. NETHERCUT,
"Secretary."

National Safety Council, 1921 Campaign

A plan to apply the Foch strategy which won the world war to the war on industrial accidents is announced at the headquarters of the National Safety Council in Chicago. For eight years accident prevention work, where it has been organized at all, has been conducted without any centralized control or direction. Although there has been through the medium of the National Safety Council a constant exchange of information regarding the most effective methods of preventing accidents, safety campaigns have been conducted independently in each of the 8,000 member plants of the Council. Despite the great strides which have been made in the prevention of accidents by these scattered campaigns, there are still approximately 22,000 workers killed, and 600,000 injured in industrial accidents each year. It is expected that the new plan will make possible great reductions in these figures, and the saving of hundreds of thousands of dollars.

During 1921 the members of the Council under this new plan are for the first time attempting a unified and intensive accident prevention campaign. The plan announced by the Council calls for a concentrated at-

tack, through all available means, on a different hazard each month, and these attacks are to be carried on simultaneously in all the plants operated by the members of the Council, except where special local conditions warrant alteration of the plan developed at headquarters.

Thus during January in approximately 8,000 industrial plants, mines, railroads and other public utilities throughout the country a special campaign was conducted against ladder accidents. It is estimated that 1,000 persons are killed in ladder accidents each year. The February campaign, now under war, is against neglect of minor injuries and infections arising therefrom.

Campaigns are announced for the other ten months against the following hazard:

March	Unsafe Clothing
April	Horse Play
May	Hand Tool Hazards
June	Standing or Sitting in Dangerous Places
July	Machinery Hazards
August	Inattention
September	Fire
October	Health Hazards
November	Careless Handling of Materials
December	Eye Injuries

American Concrete Institute

The Seventeenth Annual Convention of the American Concrete Institute was held at the Auditorium Hotel, Chicago, February 14th, 15th and 16th, 1921. This Society is in a prosperous condition. It was organized in 1905 and now has a membership of 653. The attendance at this convention was approximately 200, which is a very good indication of the interest the members take in the Institute.

Mr. Henry C. Turner, of New York City, is President and the very efficient Secretary is Mr. Harvey Whipple, of Detroit. Mr. Turner, in opening the convention, commented upon the satisfactory growth of the Institute, the membership having increased 50 per cent during the last year. This was in spite of business conditions which were not favorable. Mr. Turner also called attention to the feeling that the work of the Institute overlapped with that of the American Society of Civil Engineers and the American Society for Testing Materials. He maintained that the apparent overlapping was not real inasmuch as neither of these societies included in their program the practical subjects which are included in the program of the Institute.

The necessity for research was emphasized by a number of speakers. Prof. Hatt, of Purdue University, in reporting for the Research Committee, outlined a number of important subjects which should be given scientific attention by research laboratories. One of the most important of these is the matter of highway construction. Prof. Hatt stated that there is a billion and a half dollars to be spent on highways at the present time and that research had been neglected to such an extent that comparatively little knowledge of scientific value was now available to determine the best type of construction.

Mr. Sanford E. Thompson, Consulting Engineer of Boston, presented the Wasson Medal to Walter A. Hull, of the Bureau of Standards, Washington, for his paper on "Fire Testing of Concrete Columns." Mr. Thompson emphasized the value of well written technical papers and stated that among the principles which should be included in the writing of papers are the following: Clearness of expression, conciseness, confirming data and, most important of all, definite conclusions. For clearness it is best to place the conclusions in the introduction to your paper, as an assistance to the reader in a clear understanding of the object and scope of the paper.

In determining the value of Mr. Hull's paper the following elements were considered: Composition, originality, usefulness and breadth of field.

Mr. Hull, in accepting the Wasson Medal, expressed his high appreciation of the honor which was conferred upon him. It was interesting to note that he said that while writing the paper he had in mind all the time competing for the medal. This was an incentive to him which he thought was very proper in the preparation of a technical paper.

The program for the American Concrete Institute contained a large number of important papers. Among the chief subjects discussed were, Roads, Contractors' Plants, Concrete Products, and Reinforced Concrete Design.

Altogether, the Convention was very successful and of great benefit to those who attended. Without attempting to be extremely technical, and with a clear intention to be practical and at the same time progressive, the members of this Institute, both those who are eminent in the profession and those who are prominent in construction work, have entered cordially to advance the practice of concrete construction.

The Institute generally meets in Chicago. It is rather interesting to note, however, that the membership from Chicago is considerably smaller than that from other large cities. At the next meeting of the Institute the Western Society of Engineers will be very glad to co-operate as fully as possible.

A Special Assessment Improvement

Don E. Marsh, M. W. S. E.

There are always some outstanding features in the originating and constructing of any public improvement.

The writer makes no attempt in this short paper to offer a solution of the problems in connection with this particular improvement, but rather an effort is made to suggest certain difficulties which are met in almost every similar improvement.

The improvement under consideration is that of a reinforced concrete pavement, an ordinance for which was passed by the Village Board of Winnetka, Illinois, on February 5th, 1918.

The proceedings were conducted in accordance with the Special Assessment laws of the State of Illinois. The ordinance was confirmed by the Superior Court of Cook County, and the bids for the construction of the improvement were opened on March 31st, 1919. The ordinance covered the grading of the former turnpike roadway, the drainage system, and the concrete pavement only slightly less than five miles in length.

The ordinance for this improvement differed from many special assessment ordinances in that, so far as possible, information was given in drawings, maps, and details, rather than by verbal description. The drawing showing the district of the entire improvement was large, and required folding, while all other drawings showing details, sections and methods were made either on sheets of standard size 8½x11 inches, or reduced to this size by photography.

The concrete pavement was designed with wire fabric reinforcing, joints unarmoured and filled with asphaltic felt, and with integral curbs. The bottom surface of the concrete, and likewise the surface of the subgrade, was designed to slope toward the center. The method of finishing the concrete was with hand roller and belt. The slump test was used to determine the water content of the concrete.

The pavement has now been used approximately one year. When the weather began to warm up last spring several of the joints heaved, or rather one slab raised higher at the joint than the adjoining slab. Upon investigation this heaving was found to occur, in each instance, either at the junction between the work of separate days, or at the first joint away from the junction.

Railroad Record Since March 1, 1920

In the nine full months since the Government turned back the railroads to their owners on March 1, the railroad companies under private operation have:

1. Increased the average movement per freight car per day 6.3 miles—from 22.3 to 28.6 miles.
2. Increased the average load per car 1.7 tons—from 28.3 to 30 tons.
3. Made substantial reduction in the number of unserviceable locomotives.
4. Reduced the accumulation of loaded but unmoved freight cars from 103,237 on March 1, to 21,991 on December 3, of which only 6,386 were detained because of the inability of the railroads to move them.
5. Relocated approximately 180,000 box cars from the East to the West for the movement of farm produce.
6. Relocated approximately 180,000 open top cars from the West to the East to keep up the production of coal.
7. Moved the third highest coal production in the history of the country.
8. Spent over $500,000,000 extra on improving the maintenance of tracks, bridges, cars and locomotives.
9. Contracted to spend about $250,000,000 largely out of earnings for additions and betterments to promote the movement of cars.
10. Made arrangements to purchase approximately 50,000 new freight cars, 1,500 new locomotives, and 1,000 new passenger cars.
11. Begun the reconstruction of thousands of old cars.
12. Moved—with a deteriorated plant, under disturbed labor and business conditions—the largest volume of traffic ever known in a single year with the highest efficiency yet achieved, and with a minimum addition to the value of the property on which the public has to pay a return through rates.

Spring Meeting A. S. M. E.

May 23rd through 26th has been set as the date of the Spring Meeting of the American Society of Mechanical Engineers. It will be held in Chicago at the Congress Hotel.

Sessions are planned by the Professional Sections on Aeronautics, Fuels, Management, Material Handling, Machine Shop, Power, Forest Products and Railroads.

Communications may be directed to Mr. C. E. Davies, Assistant Secretary (Meetings), 29 West 39th street, New York.

Attendance at Our Technical Meetings

During this present season the Program Committee has furnished some excellent speakers and subjects. It is probable that very few seasons had a better arranger program. It is a fact, however, that the attendance at these meetings has been poor, lamentably so. While engineers are inclined to wait until technical papers are published so that they can read them at their convenience, there is never the satisfaction or benefit in that manner which comes from listening to the verbal presentation of papers. There is a personality of speaker which it is not possible to place upon a printed page. Then there are the illustrations which are always more abundant in the verbal presentation than in the printed paper. There is the inspiration which comes from touching elbows with your fellow engineer, rather than the cold isolation of private reading.

The chairman of a recent meeting made the following remarks:

"Before introducing the speaker of the evening, I would like to make a few remarks especially considering the attainments at our meetings, and more especially at the metings of this section of the Western Society. I believe, considering the high grade of the papers that have been presented through the past year that the speakers are justified in expecting much better attendance at the meetings, and I believe if all of the members would take it upon themselves to encourage one or two others to accompany them to the meetings at nights, we would have a much better turnout. It really seems an insult to the speakers when you consider the great amount of time they put in preparing these papers that they haven't a better attendance. Of course most of us can satisfy ourselves by saying, 'Well, we will see it in the proceedings later on,' but that is not it, it doesn't put the punch in the paper that the personal contact does the night the paper is delivered, and there is every inducement to have some very good discussion when there is a good attendance. With a poor attendance we very seldom have much discussion of these papers, and I am sure most of us will get a greater benefit out of the papers by a good, healthy discussion, and I believe if all of us would keep the matter in mind to try to bring one or two members or friends who may later on become members, I think we will derive much greater benefit from these meetings."

Our Society should give more consideration to our technical meetings and if we find that the membership does not care for technical meetings the efforts of the Society should be directed along lines which will bring a satisfactory response from our membership. The success of the Noon-day Luncheons would probably indicate one of the methods what we should undertake in order to bring our members together.

Spring Meeting, American Society of Mechanical Engineers

The Spring Meeting will be held in Chicago during the week of May 23rd. The program as soon as prepared will be announced in this Journal.

The Western Society of Engineers has on many occasions tendered its good services in making the meetings of National Societies successful, which has always resulted in reciprocal relations.

Mr. Calvin W. Rice, Secretary A. S. M. E., writes as follows:

Mr. Edgar S. Nethercut, Secretary,
Western Society of Engineers,
1735 Monadnock Block,
Chicago, Illinois.

My Dear Sir: Recently I received your good wishes and kind offer of co-operation through Professor Philbrick and Mr. Davies, of our staff. We have long recognized that the Western Society of Engineers has been doing remarkable work and your expressions of good feeling were received with considerable gratification.

It is with great pleasure, therefore, that the Western Society of Engineers is invited to participate in the Spring Meeting of The American Society of Mechanical Engineers to be held in Chicago, May 23rd to 26th. Not only do we desire to have your members feel free to attend our technical sessions, excursions and social events, but we also hope that we may have your assistance in the conduct of a session of the meeting which will consider the problems of Chicago as a rail and water gateway. This assistance may take the form of a committee to co-operate with Professor Philbrook's Committee in arranging for the session.

We hope that The American Society of Mechanical Engineers can live up to the standard of co-operation you have set in this meeting and that our relations will continue to be of the best.

Yours truly,

(Signed) CALVIN W. RICE,
Secretary.

Unethical Advertising

It may be difficult to draw a line between ethical and unethical advertising, the principal underlying ethics is so clear that one can easily avoid any unprofessional criticism of his brethren.

A member writes as follows:

"Dear Sir:

"The enclosed letter has just come to hand. This communication presumes to cast a cloak of incompetency over all Plant and Company Engineers as a body.

"In my opinion, there are probably as many capable and experienced Engineers who are employed by or serve as officials of our railways, power systems and industrial corporations as there are among the rank of Consulting Engineers.

"It would be just as reasonable for this branch of Engineers, to make the statement that Consulting Engineers were, as a body, incapable and otherwise they would be retained in the employ of the large industrial corporations.

"This form of advertising, therefore, appears unethical to me and for that reason I am calling it to your attention."

The letter to which he refers reads:

"Gentlemen:

"Many of the larger companies maintain their own engineering departments and some of them have very good engineers; but my observation in working on salaried positions along with other engineers for companies both large and small has been that as soon as an engineer has gained sufficient experience to enable him to have confidence in his ability to handle all of the various features of engineering problems, he starts in business for himself; and the company loses his services just when he has become efficient.

"It is true that many engineers continue in the employ of the same company for years and seem to be contented; but you will always find such men to be lacking somewhere. They haven't the opportunity to acquire the wide range of engineering experience that a consulting engineer has who is continually being brought in contact with all of the latest methods and equipment of engineering practice.

"Many of the large companies have come to realize this and are retaining consulting engineers on yearly contracts; even those who maintain their own engineering departments are now retaining consulting engineers."

Believing that this form of advertising should be discouraged this letter was submitted to some of our members for criticism. One member writes:

"In my opinion the letter complained of is not only unprofessional but it is decidedly crude and tends to defeat its evident purpose.

"In my opinion it should not be considered improper to solicit employment. However, it would seem that an attempt to be employed through the disparagement of another engineer, whether employed on a salary or otherwise, is a violation of a fundamental principle of ethics."

Quoting from another letter the following comments are offered:

"I can only guess at the kind of services that the author of the letter which you quote is offering. The definite conclusions he reaches on this generalizations are probably a measure of his judgment and therefore unconsciously betray the value or lack of value of that judgment. Of course the statements are not based on facts and it is hardly worth while to spend any effort to refute them. According to his standards, engineers who remain with large companies do 'have something lacking' but I should say this lack is very commendable.

"I assume from the fact that this has been called to your attention by a member (again an assumption since no names are mentioned) that the author of the advertising letter is a member of our Society and therefore it is of interest to us. It seems to be a subject for a committee on discipline, but seriously the badge of membership does not guarantee brain quality and it is perhaps rather a matter for a diplomat to convince the erring member of his error. This would be a real act of charity to the offender."

The advertiser referred to is not a member of the Western Society of Engineers. However, our attention was called to this letter by a member of the Society. It is deemed advisable to give this matter publicity in the interest of the whole of the profession.

Fatigue of Metals

Engineering Foundation was established in 1914 "for the furtherance of research in science and engineering, or for the advancement in any other manner of the profession of Engineering and the good of mankind."

Each month is published a Research Narrative which is most interesting. Fatigue of Metals—a story of co-operation—is the subject of Narrative No. 2, issued February 1, 1921, and is based upon information from Prof. H. F. Moore, Engineering Experiment Station, University of Illinois, Urbana, Ill., in charge of research.

Do the metals get tired? In school-days we "orated" about tireless "steel-sinewed" athletes. Now, forsooth, the word "fatigue"

is being used by men of science as the most suggestive name for certain kinds of failures of steel and other metals. Metal of apparently excellent quality breaks without warning in crank-shafts of airplanes, in parts of steam turbines, in other rapidly moving machines, in members of bridges subjected to vibration and frequent changes of stress. What are the causes? How can such failures be avoided? What are the limits of endurance of various metals under many repetitions of stress?

Answers to these questions became especially important during the war, and particularly in connection with military aviation. A committee of engineers and scientists organized by National Research Council and Engineering Foundation undertook a study. The problem proved complex and its study costly. But lives and property are in jeopardy through lack of knowledge. Therefore, the study has been continued. After the armistice, the Division of Engineering of National Research Council turned to Engineering Experiment Station of the University of Illinois had been connected with the early study and had the men and some of the facilities needed for further research.

In October, 1919, the three organizations mentioned entered into an agreement for two years, Engineering Foundations undertaking to provide $30,000, in installments as needed. A limited line of experiments was inaugurated. Certain manufacturers contributed test specimens of steel. Special machines were constructed and methods devised. Under known conditions many specimens are being subjected to millions of repetitions or changes of stress. Information of practical importance is emerging from the accumulating records of hundreds of observations.

In the Fall of 1920, the General Electric Company requested an extension of the program of tests to cover certain nickel steels in which it is interested as a builder of steam turbines. To meet the expense, the Company offered $30,000. A supplementary agreement was undertaken and the new work has been started. The company gets, incidentally, the benefits of the experience already gained, the special facilities developed, and the general supervision of the committee of expert metallurgists and testing engineers, organized for this research by National Research Council and Engineering Foundations.

Other users and producers of wrought or cast metals can secure valuable information at relatively small cost, by taking advantage of the existing staff and facilities for expanding this research in fields or peculiar interest to them. Each group of special tests helps in the understanding of the general problem.

This co-operative research is an example of one of the most effective uses for the funds of Engineering Foundation. By a relatively modest expenditure, the Foundation initiated the tests and carried them far enough to demonstrate their usefulness to the industries concerned; through the affiliation between the Foundation and the Research Council, the advice of the leading men of science in this field is contributed for the determination of methods and the interpretation of results. Similar procedure can be aplied to other kinds of researches.

Engineering Foundation is willing to function in this manner to the extent that the resources put at its disposal will permit. It could use larger funds than it now has.

Mid-Winter Meeting, National Safety Council, Philadelphia

Practically all of the data available on the subjects of dust explosions, crane overhoist limit stops, signals and signalling in industry, and the relation of boiler accessories to safety was gathered together and discussed at the mid-winter meeting of the Engineering Section of the National Safety Council which was held in Philadelphia, February 28th.

The meeting was held jointly with the Philadelphia Section of the American Society of Mechanical Engineers and the Philadelphia Local Safety Council of the National Safety Council. Members of the Philadelphia Section of the Association of Iron and Steel Electrical Engineers were invited.

The program was as follows:

1.—"The Engineering Aspects of Signalling," A. H. Rudd, Chief Signal Engineer, Pennsylvania System, Philadelphia.

2—"Crane Overhoist Limit Stops," D. M. Petty, Electrical Engineer Bethlehem Steel Company, Bethlehem, Pa.

3—"The Relation of Boiler Accessories to Safety," Warren Hilleary, Superintendent of Schedule Rating, Royal Indemnity Company, New York City.

4—"The Lubrication of Air Compressors," Dr. A. D. Risteen, Director of Technical Research, Travelers' Insurance Company, Hartford, Conn.

5—"Lessons from Electrical Fatalities," S. E. Whiting, Assistant Chief Engineer, Liberty Mutual Insurance Company, Boston, Mass.

The program for the evening meeting included two formal addresses to be followed by general discussion, as follows:

1—"A Broader Field for the Engineer," Prof. Dexter S. Kimball, Engineering College, Cornell University, Utica, N. Y.

2—"Safety, the Fundamental of All Engineering," Chairman L. A. DeBlois, Engineering Section, E. I. DuPont de Nemours & Co., Wilmington, Del.

Illinois Society of Engineers

The Annual Meeting of the Society of Engineers was held at the Great Northern Hotel, Chicago, January 26th to 28th, with the unusually high registered attendance of nearly 150, including abou 90 members. More than 30 new members were elected.

Officers—The Society's officers for 1921 are as follows: President, S. A. Greeley, Chicago; vice-president, R. I. Randolph, Chicago; trustees, G. H. Reiter, Chicago; G. F. Burch, Springfield; M. L. Euger, Urbana; W. D. P. Warren, Decatur; secretary and treasurer, E. E. R. Tratman, Wheaton, Ill. The 1922 meeting will be held at Decatur, Ill.

The sections elected chairmen as follows: Drainage Section, W. P. Bushnel, Quincy; Surveying Section, A. L. Webster, Wheaton; Sewerage Section, W. S. Shields, Chicago; Roads and Pavement Section, C. C. Wiley, Urbana.

After the address by the retiring president, F. C. Lohmann, of Champaign, an interesting address on "Special Assessments and the Local Improvement Law" was given by Major Edgar B. Tolman ,of Chicago, who pointed out that in order to make these securities attractive to bankers and investors it is absolutely necessary to have interest payments made regularly and on the exact date specified. After brisk discussion it was voted to have a committee appointed to consider amendments to the Local Improvement Law.

At the afternoon session the Drainage Section (G. W. Pickels presiding) had three papers: "A Drainage Survey of Illinois," by Mr. Hance, of the State Geological Survey; "Design of the Drainage Systems,' by J. W. Dappert; and "Economic Accuracy and Cost of Surveys," by Edmund T. ,erkins (read by L. K. Sherman). The Surveying Section followed (Wm. Kramer presiding) with four papers: "Perpetuation of Land Monuments and Markers," P. E. Kolylehner; "Preservation of Section Corners Under Pavements," B. H. Suhr; "Land Surveying as a District Profession," Wm. Kramer, and "What Is a Permanent Corner?", by W. D. Jones. It was voted to have a committee appointed to consider legislation for the perpetuation of section corners. Opinions were expressed in favor of amending the surveyors' licensing law so as to apply to the whole state (instead of Cook County), but no action was taken.

The evening session was in charge of the Sewerage Section (S. A. Greeley, presiding). Addresses on recent developments in sewage treatment were given by Dr. A. M. Buswell, director of the State Water Survey, and by Langden Pearse, sanitary engineer of the Sanitary District of Chicago. A paper on the activated sludge plant at Grand Rapids, Mich., was given by the engineer, M. P. Adams.

On January 27th, the morning session was in charge of the Bond and Pavement Section (H. J. Fixmer presiding), and several papers were read: "Local Conditions and the Design of Brick Pavements," M. B. Breenough; "Bituminous Pavement Construction," H. W. Skidmore; "Contracts and Specifications," Geo. W| Tillson, consulting engineer; "Alignment and Grades for Modern Roads," R. E. Toms, U. S. Bureau of Public Roads; "Wear and Strength of Concrete," D. A. Abrams; "Concrete Roads," S. T. Morse; "Research in Highway Problems," C. C. Wiley; "Highway Transport Surveys," A. H. Blancvhard, University of Michigan.

On January 28th at the afternoon session (H. F. Ferguson presiding) the report of the Committee on Water Supply was presented by G. C. Habermeyer and W. D. P. Warren; a paper on "Water Supplies in Small Cities" was read by Wm. Artingstall. After the business session and the election of officers the meting adjourned.

In the competition for $25 prizes for papers two awards were announced by Prof. A. N. Talbot, chairman of the judges: "How to Keep Smooth Pavements," by H. H. Edwards, city engineer of Danville; "The Future of Asphalt Pavements," by Allen Dimmick, Chicago.

The report of the Committee on Co-operation, read by Paul Hansen, recommended a ballot vote on a proposition to affiliate with the American Association of Engineers. Other plans were suggested in a prolonged discussion. The outcome was the appointment of a committee to submit to the Executive Board changes in the constitution which will permit of affiliation with any other society.

The annual dinner, held at the Great Northern Hotel, was a great success, with nearly 100 present to enjoy the dinner, the sociability, music and speeches. Three excursions were arranged; to the Calumet sewage pumping station and sewage treatment plant of the Sanitary District of Chicago, to the stock yards, and to the Universal Cement plant at Buffington.

Resolutions.—(1) suggesting that the State Highway Division should construct experimental sections of paving of different types; (2) advocating extension of farm drainage; (3) favoring more favorable legislation to enable municipalities to finance water works construction; (4) urging that the State adopt the program of the U. S. Geological Survey for more rapid progress on the tepegraphic mapping of the country

and that it should appropriate $35,000 yearly for this purpose; (5) urging the State Highway Divisions to co-operate with county officials in preserving and re-establishing section corners; (6) requesting the governor to retain the present director of the State Department of Public Health; (7, endorsing the principle of regulating public utilities by a State Commission; (8) urging the State Legislature to provide the needed financial support for the University of Illinois.

Design of Ideal Road

LINCOLN HIGHWAY ASSOCIATION.

In working towards a design for a model section of the Lincoln Highway—a section which, without compromise with the question of available funds, can represent the consensus of the best engineering opinion of the United States as to the most economical investment of public funds on main interstate routes of travel—the Lincoln Highway Association first sent a questionaire to a list of over 4,600 highway engineers, professors of highway engineering and state, county and local officials in every section of the Union. A wide divergence of opinion was indicated by the responses received to the questionaire. But those engineers and commissioners who recently met in New York City, appeared to have well defined ideas as to the proper limitations to be placed on investments in highway construction and as to what conditions it is wise to anticipate in constructing highways now for the use of the developing traffic of the next twenty years.

Some of the foremost highway engineers in the United States were represented in the recent meetings of the Association's Technical Committee. The fact of the matter is that the personnel of the Committee itself, has, collectively, jurisdiction over the expenditure of considerably more than a quarter of a billion dollars for highways. The ideas of these men therefore as to what constitutes an ideal section of main interstate road, like the Lincoln Highway, are of the widest possible interest.

In two days of continuous discussion the Technical Committee encountered very few radical differences of opinion and it is expected that another meeting, to be held in the near future in Chicago, will permit of the final determination upon the general design of the educational section.

TREND TO WIDER, MORE PERMANENT ROADS.

The general points of design determined upon by the meetings just held, are important as indicating the trend of opinion on the part of those men who have in charge the construction of thousands of miles of main line American highways, during their terms of office. They are further important as being of suggestive value to those having in charge other thousands of miles of main highway construction in every section of the Union.

The general specifications indicated below are all subject to review by the final meeting of the Technical Committee, at which the attendance of several members who could not be at the New York meeting is expected.

1. The specifications for the Ideal Section are to be predicated upon an average traffic of 15,000 passenger automobiles per 24 hour day, traveling at a speed of 35 miles per hour, and 5,000 motor trucks per 24 hour day, traveling at an average speed of 10 miles per hour.

2. The width of right-of-way for the Ideal Section shall be 100 feet.

3. The drainage for the Ideal Section shall consist of submerged drain tile and catch basins.

4. The Ideal Section shall be constructed of concrete, 10 inches thick, with reinforcing steel embedded.

5. The Ideal Section shall be designed with earth shoulders on each side of concrete.

6. The Ideal Section shall be lighted.

7. The Ideal Section's Technical Committee recommends that the Ideal Section or no other road should be built without adequate, intelligent, continuous and prompt maintenance being provided.

8. The Ideal Section should embody no curves having a radius of less than 1,000 feet and wherever reasonably possible curves should be eliminated entirely.

9. Curves on the Ideal Section shall be super-elevated for a speed of 35 miles per hour.

10. The Ideal Section shall provide a foot path for pedestrians.

11. The Ideal Section shall be equipped with guard and warning sign and all embankments shall be protected by guard rails.

12. Specifications for the Ideal Section shall be predicated on the ultimate regulation of motor truck design, limiting the superimposed load to 800 pounds per inch of width of tire actually in contact with the road surface and to 8,000 pounds per wheel.

13. On the Ideal Section all crossings at grade shall be eliminated.

14. The Technical Committee recommends the establishment of comfort stations, park sites and camp sites along the Ideal Section.

15. All wires along the Ideal Section shall be placed underground.

16. All advertising signs are prohibited along the right-of-way of the Ideal Section and all signs of direction or distance, except those placed or authorized by proper state authority, are prohibited.

17. It is the sense of the Ideal Section's Technical Committee that all distance markings should originate at the municipal headquarters of any town or city.

18. It is the sense of the Ideal Section's Technical Committee that insofar as may be practical all obstructions to the vision shall be removed at intersecting roads for a distance of at least 500 feet each way from the intersection.

All of the above decisions were unanimous, with the exception of the total travel upon which the specifications are predicated, in which one member dissented, and the item number 12, predicating specifications upon a regulation of motor truck design, to which one member dissented.

It should be noted that the width of right-of-way decided upon, i. e. 100 feet, is well above that in general use at this time. It is also interesting to note that the Board of Engineers passing upon this question have arbitrarily assumed that the limits of highway design can be drawn at a total traffic density per day of 20,000 mixed passenger and freight vehicles and that when traffic passes this point, it is desirable to construct another paralleling road, rather than to increase the width or strength of the existing road to the end of concentrating the additional travel upon it.

The unanimous agreement of the Technical Committee upon the necessity of submerged drain tile and catch basins, rather than the prevalent open ditch, is of considerable importance as indicating a feeling on the part of these Highway Engineers that the open ditch is going to ultimately be eliminated on all main routes of travel.

The unanimous decision that the Ideal Section should be lighted is also of great interest to those forward-looking highway administrators who are now giving careful consideration to the problems which will develop during the next ten years.

One of the most important matters to be decided upon by the Ideal Section Technical Committee and which must precede any construction, is the question of cross section design, i. e. the number and arrangement of traffic lanes, to be provided on the Ideal Section. This was practically the only point upon which a disagreement was encountered. Some of the engineers feeling that the construction of a three-traffic-lane pavement, say 27 feet wide, would be the proper procedure, while others preferred the construction of a four-traffic-lane, separated by a central parkway, to the end of segregating travel according to direction. Others were in favor of separate travel lanes for motor trucks and passenger cars.

The Lincoln Highway Association is having competent engineers draw up suggested specifications for each of these cross section designs and the matter will be carefully considered at the next meeting of the Technical Committee.

The Lincoln Highway Association, as well as the Office of Public Roads of the Federal Government, will issue bulletins concerning the specifications determined upon, which will be of very wide technical and general interest.

Is Engineering a Profession?

Many Engineers are employed in a consulting capacity and receive compensation in the form of fees. A larger number are employed directly by the industries and utilities.

In this way the employment is somewhat different from that of other professions, such as Law, Medicine and possibly Architecture.

The Century Dictionary defines a profession as follows:

"The calling or occupation which one professes to understand and to follow; vocation; specifically, a vocation in which a professed knowledge of some department of science or learning is used by its practical application to affairs of others, either in advising, guiding, or teaching them, or in serving their interests or welfare in the practice of an art founded on it.

"Formerly theology, law and medicine were specifically known as the professions; but, as the applications of science and learning are extended to other departments of affairs, other vocations also receive the name. The word implies professed attainments in special knowledge, as distinguished from mere study or investigation; and an application of such knowledge to uses for others as a vocation, as distinguished from its pursuit for one's own purposes. In professions strictly so called a preliminary examination as to qualifications is usually demanded by law or usage, and a license or other official authority founded thereon required. In law the significance of the word has been contested under statutes imposing taxes on persons pursuing any 'occupation, trade, or profession,' and under statutes authorizing arrest in civil actions for misconduct in a 'professional employment'; and it has been, in the former use, held clearly to include the vocation of an attorney, and upon the same principle could doubtless include physicians, unless the mention of trade, etc., in the same clause of the statute be ground for interpreting the statute as relating only to business vocation. Professional employment, in statutes allowing ar-

rest ,is regarded as not including a private agency like that of a factor or a real estate broker, which can be taken up and laid down at pleasure."

Another definition is also frequently quoted.

"A profession is a vocation founded upon specialized educational training, the purpose of which is to supply disinterested counsel and service to others for a direct and definite compensation wholly apart from expectation of other business gain."

While the popular use of the word Engineer is wide and includes the artisan, the profession of Engineering is well defined. The definition of a profession does not seem to be based on the terms of employment.

Probably no other profession has contributed more to the benefit of mankind than that of Engineering.

Code of Practice and Schedule of Fees for Structural Engineers

A Code of Practice and Schedule of Fees for Structural Engineers has been adopted by the Structural Engineers' Association of Illinois. We are permitted to publish the same for the information of our members. The value of a code is recognized and nearly all societies have considered and adopted some form of code. In reality the Golden Rule contains all that is necessary. The reading of this Golden Rule is sometimes neglected in our hurry. Therefore we accept a modern version very much more in detail as our guide.

Both the Code of Practice and the recommended Schedule of Fees have been copyrighted by the Structural Engineers' Association of Illinois.

CODE OF PRACTICE AS RECOMMENDED BY THE STRUCTURAL ENGINEERS' ASSOCIATION OF ILLINOIS FOR THE USE OF ITS MEMBERS.

Adopted January 3, 1921.

PREAMBLE.

In his relation to the client or to the public, the Structural Engineer should carefully maintain the responsibility and trust which has been reposed in him, bearing in mind that a violation of trust manifests itself as a discredit to him and casts serious reflects upon the entire profession.

In the relations between the Structural Engineer and a client, the Engineer should so regulate his conduct as to preserve the dignity of the profession. Judgment should be reserved where a hasty partially considered decision might result in loss to the client or reflect upon the Engineer's professional ability. In a judicial capacity between the client and a second party, he should act with strictest impartiality, basing his final decision upon the true merits of the case, and under no circumstance should he permit any personal interests, either his own or those of his client, to influence his decision.

The practice of Structural Engineering includes undertakings of great responsibility, involving the welfare and safety of the public. The Structural Engineer is one whom the public may accept as specially qualified to take this responsibility, and he should so establish himself as to preserve and maintain all that is implied by the Engineering Act.

CODE OF PRACTICE.

The following principles have been formulated for the purpose of establishing a standard to which all Structural Engineers can conform. A uniform observance of these principles is required to the end that no particular Structural Engineer or group of Structural Engineers shall profit by virtue of special privilege, but rather, having placed all on a common basis, the success or failure of each will be determined solely by his professional ability and business acumen.

PROFESSIONAL RELATIONS.

The relations between Structural Engineers should be of strictest co-operation. No Structural Engineer should unjustly condemn the professional work or acts of another Engineer, and any such unjust condemnation or criticism by a member of this Association will render him liable to suspension from membership on the grounds of unprofessional conduct.

EXPERT EVIDENCE.

Where a Structural Engineer has been engaged as an expert witness, he shall confine his testimony, so far as practicable, to the necessary exposition of facts, figures or engineering theory, as will permit the court or the jury to reach a fair and equitable decision.

PARTICIPATION IN PUBLIC AFFAIRS.

This Association is in favor of an active participation by its members in all public affairs, particularly those related to engineering.

The Association believes that the tendency of Municipalities, the State, and the National Government, of naming laymen only, on committees whose duty it is to investigate and report on matters of a technical or quasi technical nature should be so modified that at least a majority in the membership of such committees will consist of engineers.

The Association asks its members to assist in the general dissemination of this principle and to spare no effort in securing this end.

ADVERTISING.

This Association stands committed to the belief that advertising, particularly in the form of business cards in technical magazines ,is proper, and strictly professional. The Structural Engineer is urged to place suitable tablets, signs or placards on all structures, the design or construction of which are under his direction, and he should not hesitate to secure publicity in the press if the nature of his work justifies such a step.

He should, however, see that whatever press publicity he secures is of an impersonal nature, strictly barring all false claims or representations.

The Association is not in favor of solicitation of business through the medium of circulars of an advertising nature and urges all of its members to refrain from this form of advertising.

L COMPETITION. L

Members of this Association are encouraged to enter competitions in a manner outlined under Schedule of Fees, particularly in the design of bridges and buildings. In this way the profession will be greatly benefited and good design stimulated.

No member of this Association may either actively or passively enter into, or become a part of any pool or clique, whose object it is to impair the honesty of any competition. A member of this Association found guilty of such practice will be dismissed from membership on the grounds of unprofessional conduct.

A member of this Association may not knowingly attempt to obtain a professional engagement already in possession of another Structural Engineer or Architect except by the specific invitation of the client, and then only after ascertaining that there is good and sufficient reason for making the change.

UNFAIR COMPETITION.

A member of this Association may accept compensation for service from one interested party only, except in the event that more than one party is involved, when other compensation may be accepted, providing all parties interested agree thereto.

No member of this Association may receive, directly or indirectly, any royalty, gratuity or special fee, on any patented article or process used in the work upon which he is retained, without the consent of his client.

CO-OPERATION.

All members of this Association are urged, so far as circumstances will permit, to assist fellow members, by the exchange of general information and experience, or by instruction through the Engineering Societies, the schools of applied science and the technical press.

Copyrighting of designs, plans and specifications, with or without supporting design data, is strongly recommended by this Association, and all members are urged to record their work in this manner.

SCHEDULE OF FEES AS RECOMMENDED BY THE STRUCTURAL ENGINEERS' ASSOCIATION OF ILLINOIS.

Adopted January 3, 1921.

PREFACE.

The following schedule, prepared and authorized by the Association, is herein presented with a view of providing a guide for the mutual protection of its members and their clients. This schedule represents a minimum fee to be charged.

The charge for professional services shall be based upon:

(A) A per diem rate.

(B) A retainer fee.

(C) A percentage of the cost of the work.

(D) Actual Engineering Cost plus a fixed fee.

(A) PER DIEM RATE.

The charge for professional services,for consultations, studies, investigations, reports, and for expert testimony and preparatory work incident to law suits, shall be as follows:

(1) For short engagements on any of the above work,a minimum fee of One Hundred ($100.00) Dollars per day shall be charged.

(2) For preliminary studies, for investigations and for reports, made to determine whether the Engineer can support the claims of the client, as for example prior to a law suit, a minimum fee of Fifty ($50.00) Dollars per day shall be charged.

(3) For submitting a report and reviewing the design prepared by others, for existing or proposed work, a minimum fee of One Hundred ($100.00) Dollars per day shall be charged for the first week, Seventy-five ($75.00) Dollars per day for the next week, and Fifty ($50.00) Dollars for each day thereafter until the specific work is completed.

(4) The above charges are intended to cover professional services only, unless otherwise previously agree to, and any expense incurred in connection with a specific engagement, such as transportation and subsistence, salaries paid assistants engaged on the work, office and field supplies, and general office expense, shall be charged the client in addition to the above fees.

(B) A RETAINER FEE.

(5) Where a member of this Association has been retained for general advice by a firm or corporation, and said retainer is for a long term of engagement, he may accept such retainers at a compensation not less than indicated in paragraphs (1), (2) and (3).

(C) PERCENTAGE OF THE COST OF THE WORK.

(6) For preliminary examinations, studies and reports on new projects, or for review, study and reports on existing or pending projects previously dealt with by others, a minimum fee of 3% of the cost of the work shall be charged.

Work under this head may be charged for under the terms of paragraph 1 to 4 (both inclusive) if preferable.

(7) For such investigations, plans, and specifications, as may be necessary to secure an intelligent bid from contractors, a minimum fee of 5½% of the cost of the work shall be charged.

(8) For final working drawings and specifications, together with necessary consultation and general advice during construction ,a minimum fee of 7½% of the cost of the work shall be charged.

(9) For professional services, including preparation of final plans, specifications and contract forms, award of contracts, superintendence during construction, testing of materials and general supervision of the work, a minimum fee of 10% of the cost of the work shall be charged.

(10) For professional services incident to engagements involving repairs or alterations to existing buildings or other structures, a fee of not less than 10% of the cost of the work shall be charged.

(11) The percentages indicated in the above paragraphs under this head, shall be construed as applying to work not exceeding One Hundred Thousand ($100,000) Dollars in cost. The minimum percentage to be applied on larged work shall be as follows:

Paragraphs.	$100,000 to $250,000	$250,000 to $500,000	$500,000 to $1,000,000	$1,000,000 and upward
6	2½%	2 %	1½%	1 %
7	5 %	4½%	4 %	3½%
8	7 %	6½%	6 %	5 %
9	9 %	7½%	6½%	5½%
10	9 %	7½%	6½%	5½%

(12) Paragraphs (6) to (11) both inclusive, are to be computed upon the total cost of the completed work, exclusive of engineering, or upon a bona fide estimated cost or bid pending the completion of the work, with an adjustment when the actual cost is known.

(13) The phrase, "cost of work" as used herein, refers only to such part or parts of the whole work or project for which the engineer has been engaged, clearly excepting, however, all buildings and other similar structures, for which the fee shall apply to the entire cost of the building, not including special machinery, lighting, heating, plumbing or ventilation, unless these items require special consideration by the engineer, in which event the percentages shall be applied whole or in part to any or all of these items as circumstances may direct.

(14) The percentages indicated in paragraphs (6) to (11) both inclusive, include all the charges mentioned in paragraph (4) unless previously otherwise agreed to.

(D) ACTUAL ENGINEERING COST PLUS A FIXED FEE.

(15) A member of this Association may accept an engagement on this basis, which contemplates a charge to the client to cover the salaries of assistants engaged on the work ,and general office expense, with an addition of from 50% to 100% for overhead. In addition to the above, the charge to the client shall be increased for the professional services of the engineer, an amount equal to not less than 50% of the fees indicated in paragraphs (6) to (11) both inclusive.

(16) It is recommended that all members of this Association require of the client a written agreement stating clearly and fully the conditions of the engagement, the period during which the work is to be executed, the amount of remuneration to be paid the engineer, and the terms of payment thereof.

(17) Where changes in plans, specifications or contracts are required by the client after work has been commenced thereon, an additional charge may be made against the client for making such changes at actual cost plus a percentage, as indicated in the first clause of paragraph (15).

(18) In the event that the project covered by an engagement is ordered abandoned upon instructions from the client, the fee which may be claimed by the engineer shall be determined by the progress made, and the expenses and obligations incurred by the engineer.

No recommendation is made to cover this contingency, and all members are urged to reach a fair and equitable agreement with the client without recourse to legal procedings or arbitration, unless unavoidable.

(19) Where an engagement has been accepted by an engineer with the expectation that an immediate start may be made thereon, and the work is delayed by the client, the engineer may ask for additional remuneration, if proceeding with the delayed work would entail an additional financial burden on him.

(20) Members of this Association may enter into competitions providing that the conditions thereof provide for a reasonable compensation to cover the cost of preparing the competitive designs, and that the conditions surrounding the competitions conform to the provisions of the Code of Practice relating thereto.

(21) Drawings, specifications, notes, letters, exhibits, etc., as instruments of service, are the property of the engineer, and shall be returned to him at the conclusion of any specific engagement.

(22) The cost of surveys, when required, are not included in any of the fees mentioned in this schedule and are to be paid for by the client, unless otherwise specifically agreed to by the engineer.

(23) Where the terms "Member of this Association,' "Structural Engineer" or "Engineer" are mentioned in the Code of Practice and in this Schedule of Fees, they shall be interpreted to mean a Registered Structural Engineer of the State of Illinois, in good standing as a member of the Structural Engineers' Association of Illinois.

NEW MEMBERS

At the meeting of the Board of Direction, held January 17th, 1921, the following new members were elected:

141 Rudolph O. Johnson, 5917 Rice St., Chicago....Student
157 C. S. Duke, 6344 Eberhardt Ave., Chicago....Member
166 Theodore Doll, 913 Hamlin St., Evanston, Ill....Transfer—Junior
167 Hubert M. Henry, 1835 S. Lincoln St., North Chicago, Ill....Transfer—Associate
168 E. Merrill Seaberg, 3599 Archer Ave., Chicago....Student
169 John C. E. Vaaler, 3818 N. Lawndale Ave., Chicago....Student
171 Elbert C. Isom, Sinclair Refining Co., Chicago....Junior
173 Wirt A. Stevens, 7543 Saginaw Ave., Chicago....Member
174 F. J. Brackett, Mt. Vernon, Iowa....Member
175 Lineol Benjamin, 7234 Indiana Ave., Chicago....Student
176 Edwin Rohrdanz, 375 Greenwood Ave., Blue Island, Ill....Student
177 Eris Ragnar Lindberg, 3014 Osgood St., Chicago....Student
178 Erwin George Baumgartner, 505 Hannah Ave., Forest Park....Student
179 Matthew Dwyer, 6015 Harper Ave., Chicago....Associate
170 John E. Titus, 53 W. Jackson Boulevard, Chicago....Member
180 Wm. C. Larson, 1409 Manhattan Bldg., Chicago....Associate

APPLICATIONS RECEIVED

Applications for membership were received by the Board of Direction since its meeting held January 17th, 1921, as follows:

1 Rector Egeland....928 N. LeClaire Ave., Chicago, Illinois
5 Alfred Gould....1904 N. Clark St., Chicago, Illinois
6 George D. Hardin....3139 Indiana Ave., Chicago, Illinois
7 Roy E. Rice....Noblesville, Indiana
8 Kahn B. Thrasher....Twelfth St. Station, Chicago, Illinois (Transfer)
9 Paul Kircher....7332 Luella Ave., Chicago, Illinois (Transfer)
10 Thomas F. Montgomery....7363 N. Ashland Blvd., Chicago, Illinois
11 A. D. Ferguson....2624 W. Lake St., Chicago, Illinois
12 Charles Wm. Chapman....309 E. 59th St., Chicago, Illinois
13 N. H. McKenzie....208 E. Illinois St., Chicago, Illinois
14 Francis Floyd Carter....26 So. Spring Ave., LaGrange, Illinois
15 Edwin L. Cheatle....1744 W. 100th St., Chicago, Illinois
16 Stanley Frederick Bristol....5323 W. Ohio St., Chicago, Illinois
17 William C. Schroeder....4 Ave. A—East, Bismarck, N. D.

Members are requested to communicate with Secretary with regard to qualifications of the above applicants for membership in the Society.

EDGAR S. NETHERCUT, *Secretary.*

EMPLOYMENT SERVICE

We wish to assist in placing valuable men in the employment most suited to them. Many concerns have positions open now or will have in the near future. What could be more logical than an engineering employer obtaining assistance from an engineering society, or an engineer looking for a position to seek a source that is in close touch with the engineering profession? You can co-operate by communicating with the Secretary's Office.

ENGINEERING EMPLOYMENT

POSITIONS AVAILABLE

A-214: POSITION OPEN. WANTED—A young man, age 27 to 30, of good character, personality and natural ability. Graduate of an engineering school of recognized standing, in mechanical engineering, prefer Massachusetts Institute of Tech., Cornell or University of Wisconsin but will consider others. Must have good knowledge of mechanics and materials; also of elements of machine design. Desire man of experience in railroad work, preferably on rolling stock equipment and its design, such as air brakes, trucks, steel car frames and bodies, or other features of this class of equipment; experience of a closely associated nature will be considered. Position open, will continue for about four months, with possibility of future permanent connection. Salary will depend on applicant's qualifications; location, Chicago. References necessary.

POSITIONS WANTED

B-860: POSITION WANTED AS SUPERINTENDENT of Construction, Chief Draftsman or Squad Foreman. Broad experience, including 17 years' architectural practice.

B-861: POSITION WANTED IN MECHANICAL drafting, general construction work or elevator and conveying machinery. Experience 16 years on machine design and detail, also general detailing in steel and wood.

B-862: POSITION WANTED AS SALES ENGINEER, Mechanical Engineer, or Designer and Draftsman. Experience three years heat treating equipment, three years general engineering and sales.

B-863: POSITION WANTED IN RAILWAY Electrification, Electric Engineering, Research or Motor Equipment for industrial plants or connection with high grade consulting engineering company. Experience, 20 years; author of several engineering articles.

B-864: POSITION WANTER AS ESTIMATOR or Designer on buildings, construction superintendent or on valuations or bridge design. Experience 13 years, including design and construction, concrete and bridge, and valuation.

B-865: POSITION WANTED BY YOUNG man just graduated from Mechanical Drafting Course, Lane Technical School. Seeks position in engineer's office to begin at the bottom where future is good.

B-866: POSITION WANTED IN CONCRETE designing, connection leading to executive position or sales engineer. Experience 5 years, concrete and building work.

B-867: POSITION WANTED WITH CONCERN where six years' experience mechanical designing of engine lathes, automatic machinery, conveyors, sand handling equipment and general foundry maintenance could be used.

B-868: POSITION WANTED AS DISTRIBUTION Engineer in Station Design or Electrical Drafting; experience two years in above work.

B-869: POSITION WANTED AS MANAGER of Power and Equipment, Master Mechanic, or Superintendent of Construction. Experience 11 years, steel foundry, rolling mill and forge plant; 9 years in erection, maintenance and consulting work.

B-872: POSITION WANTED AS RESEARCH and Development Engineer, Testing Engineer, Sales or Organization Engineer. Experience 4 years along above lines.

B-873: POSITION WANTED AS SUPERINTENDENT of Construction or Structural Designer. Experience 4 years with architectural and contracting firm.

B-874: POSITION WANTED AS ASSISTANT Chief Engineer, squad boss, checker or draftsman. Experience 15 years on general machinery and structural work. Last eight years handling men.

B-875: POSITION WANTED AS INDUSTRIAL Engineer, Personal Manager, or with statistical department banking house by graduate engineer. Five years' evperience in industrial and banking field.

B-876: POSITION WANTED AS OFFICE Engineer with railroad or mining company, Inspecting Engineer or Sales Engineer. Nine years' experience in above work.

B-877: POSITION WANTED AS DRAFTSman by graduate Secondary Technical School.

B-878: POSITION WANTED AS ELECTRIcal draftsman by graduate Secondary Technical School.

B-879: POSITION WANTED AS MECHANIcal gas or sales engineer by engineer of 12 years' experience; employed most of time with public utility company.
a licensed structural engineer.

B-880: POSITION WANTED AS SUPERINtendent of Construction, Master Mechanic or Mechanical Engineer for industrial concern; 15 years' experience in above fields. Applicant is

B-881: POSITION WANTED AS MAINTEnance Engineer of forge plant, Mechanical or Structural Draftsman or in power plant testing, by graduate Mechanical Engineer, with 5 years' experience in industrial, sales and design.

B-882: POSITION WANTED — EXECUTIVE with broad and unusual experience in purchasing, factory organization, cost and production systems; possessing tact, initiative, sound judgment and ability to secure capable subordinates, and retain their loyalty and co-operation desires position with progressive concern in any capacity wher these qualifications can be utilized.

B-883: POSITION WANTED AS MECHANIcal Draftsman or on cost work; experience 6 years at above work.

B-884: POSITION WANTED AS MECHANIcal or Structural Designer or Draftsman; experience 3 years pumping machinery as detailer; 2 years plant maintenance as draftsman; 1 year condensing machinery as designer. Location preferably in East. Salary $200 per month. Afe 30, single.

B-885: POSITION WANTED AS FACTORY Superintendent, Industrial Engineer or Production Manager. Experience 10 years special machine design, manufacturing, shop planning, efficiency and production.

B-886: POSITION WANTED AS ENGINEER, factory maintenance, mechanical drafting or lay-out or foreman on construction work. Experience 6 years along above lines.

B-887: POSITION WANTED AS SALES ENgineer, assistant in purchasing or production or mechanical drafting. Experience 8 years mechanical designer including shop work, on light and heavy machinery, industrial cars and locomotives, also general steel mill practice; 2 years sales work machine tools equipment and mechanical specialties.

B-888: POSITION WANTED AS SUPERINtendent, architectural draftsman, or estimator; experience 6 years in above work.

B-889: POSITION WANTED AS ARCHITECtural draftsman, map draftsman or tracer and letterer; experience 6 years in above work.

B-890: POSITION WANTED AS SUPERINtendent for architect, structural designer or estimator or draftsman; experience 6 years in above field.

B-891: POSITION WANTED BY ELECTRIcal Engineer; 15 years' experience in electric railway and power fields which has included design construction, operation valuation and sales work. Open for new engagement.

B-892: POSITION WANTED AS STRUCTUral designer, valuation and appraisal work or assistant superintendent of construction; graduate Armour, 1914. Experience in above fields.

B-893: POSITION WANTED AS ARCHITECtural checker, draftsman or estimator. Experience 20 years in above fields.

B-894: POSITION WANTED AS MAINTEnance Engineer, pumping and compressing plants; Operating Engineer or Erector gas or oil engines and compressor plants; 13 years' experience mining and mechanical work.

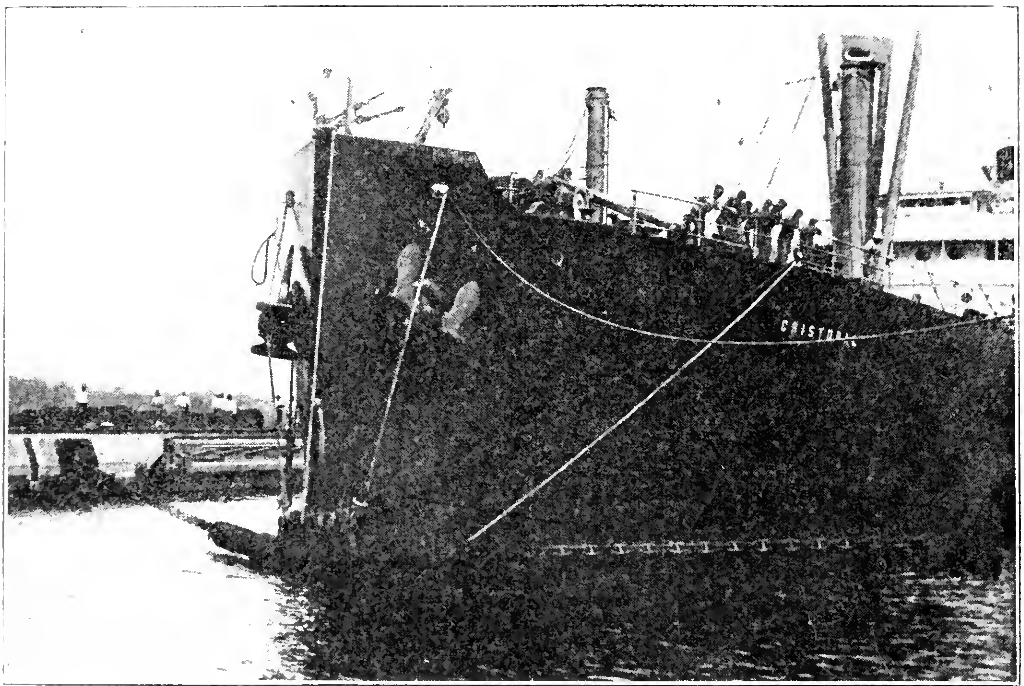
B-895: POSITION WANTED BY ENGINEER with following experience: Assistant Superintendent; Sewer installation and general construction work. Assistant Engineer; Railroad valuation work. Inventory and mapping. Assistant and Chief Engineer and head of Purchasing Department on extensive construction work for government during the period of war. Representative for manufacture of Building Specialties in Chicago.

B-896: POSITION WANTED BY BRIDGE and structural engineer. Able executive and correspondent. Has traveled extensively and has done considerable promotional work.

B-897: POSITION WANTED BY MECHANIcal engineer, now employed, as chief engineer, chief draftsman or similar situation. Have had broad experience in varied mechanical and structural designing and supervision.

INLAND WATERWAYS COMMITTEE

EDMUND T. PERKINS, Chairman



At a recent meeting the following resolution was made:

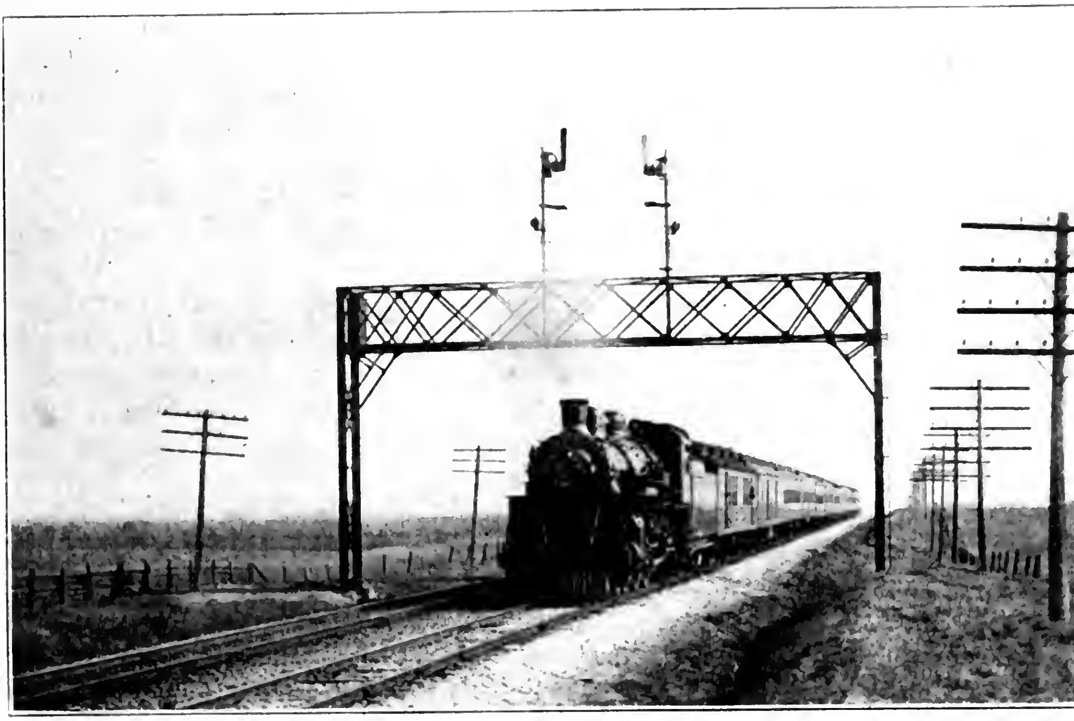
"The Waterways Committee of the Western Society of Engineers, after careful consideration of the St. Lawrence, Great Lakes Waterways project, has unanimously resolved that the deep canal connecting the Great Lakes with the St. Lawrence at Montreal is entirely feasible in an engineering sense anr altogether advisable in an economic sense;

"We further recommend that the Board of Direction of the Western Society of Engineers approve this resolution."

The Waterways Committee further reported that at its meeting held December 15th the following resolution was adopted and recommended that this resolution be published:

"We commend the Division of Waterways, Department of Public Works and Building for the skill and efficiency displayed in preparing and drafting plans for the construction of the Illinois waterway, and congratulate the people of the State for the good progress made under difficulties which has resulted in the actual letting of a contract at reasonable prices for an initial structure."

Both resolutions were approved by the Board of Direction.



THE RAILROAD SITUATION TODAY

(Address at Luncheon of Western Society of Engineers, at Chicago, February 11, 1921, by W. B. Storey, President, The A. T. & S. F. Ry.)

The history of railroading in the United States has since 1914 (the beginning of the European war) passed through a remarkable chapter, resulting in absolutely changed conditions. Up to that time we had been in what I might call a "period of experimental government control." These experiments had begun by the assumption on the part of the government of a limited dominion over rates. This had progressed from time to time, each step tightening the line of control until finally the process exercised a retarding effect on the growth and development of the country. Then came the war with its wonderful increase in the industries of the country and the absolute demonstration of the fact that the railroads had been starved to such a degree that they were not able to function properly; then the entering of this country into the war, the taking over of the railroads by the government, and finally, the change in the attitude of the public toward the whole transportation question—all these steps leading up to the passage of the Transportation Act of 1920, designed to control the railroads, but at the same time to remove the hampering influences that had resulted so disastrously. That law was passed nearly a year ago and it may be of interest to you to look at the situation today and see what has been accomplished, what remains to be done, and the outlook for the future.

The new law provided for increases in rates sufficient to cover the cost of operation and to provide sufficient for interest. It recognized that there must be an interim while the rates were being studied and hence it provided that the returns of the roads should be at a fixed figure for six months. It provided a method to settle labor disputes in an endeavor to remove the constantly impending danger which had formerly existed of possible nation-wide strikes. In its efforts to solve the problems presented, Congress changed in a measure the functions of the Interstate Commerce Commission. Formerly this had been a body to

protect the public from the railroads; it now was charged with the additional task of protecting the railroads from the public. In general terms, it put on the Interstate Commerce Commission the responsibility of making private control of the railroads a success. It is a fact that because of this law the Commission has changed its attitude toward the railroads to conform to the new conception as fixed by Congress and has done everything possible to make the new law a success. To illustrate how this has worked, I will describe how the threatened coal shortage of this winter was met.

The Northwest, which ordinarily gets its coal via boat from Lake Erie ports to the head of the lakes at Duluth and takes 28,000,000 tons annually, awoke to the fact that very little coal was moving and it came to the Commission with the statement and with a cry for help. At about the same time New England, through governors of its states, made a complaint that the railroads had fallen down in the task of supplying them with fuel and that their needs were over 23,000,000 tons. The Interstate Commerce Commission, in place of issuing orders to the railroads to deliver the coal, put the complaints up to the railroads and asked for advice as to what should be done. The railroads, through a committee of executive officers, made a study of the situation, found that the facts were as stated, and ascertained that the trouble was due to inheritances from the period of federal control and to conditions which could only be helped by orders on the part of the Interstate Commerce Commission. As a consequence, ordinary freight traffic on many western roads was almost suspended for a time and they were ordered to deliver empty coal cars to the coal-producing roads, regardless of other business, for several weeks. In addition, all coal cars were confined to the coal business. While these orders were very severe on all building construction, in which you as engineers are interested, the desired result was obtained and the country was saved a fuel famine this winter. In many other ways the Commission has been helpful, and this co-operative spirit is one of the most helpful signs for the future.

The act of the Commission in raising rates has been probably the most important single thing that has happened to the railroads of this country outside of the taking over of the railroads by the government with all that went with it. A very large deficit in the revenues of the roads had been brought about by the constantly increasing costs due to higher wages and greater unit prices for all supplies without any commensurate increase in rates. The only possible way of meeting this condition was to make a percentage increase that would apply to each region into which the country was divided. The bases for the rates necessary were valuation of each group (fixed for this purpose by the Commission), an assumed volume of business (taken by the Commission as that of 1919), and a rate of interest of 6 per cent which was allowable under the law. It was recognized that several of these factors were variable, but it was decided that the only way to reach a final and correct determination was to make a start and then modify as events indicated the necessity. New rates for the entire country, varying from 25 to 40 per cent higher than the old, were instituted and these are on trial today. Such large increases must necessarily be very far-reaching in effect. They must necessarily check to a certain degree the amount of goods transported —for instance, a certain manufacturer in Kansas who formerly sold part of his output in New England, finds that market cut off because English goods are now able to crowd out his product in that territory. While it is not believed that the increase in rates has caused the slump in business throughout the country, yet it may have had some influence in that direction and the slump in business has decreased the volume of transportation far below that of 1919, with the result

that the railroads are falling short of the necessary amounts to enable them to pay their interest, and in many cases are finding difficulty in meeting their bills. One of the important problems presented to the railroads and the Interstate Commerce Commission is to meet this particular emergency. A further horizontal increase in rates does not seem practicable as it would further check the business of the country. While we know that this condition of affairs is only temporary and that the business of the nation must revive, we do not know how soon this will be and this is very vital to many roads. Before the revival comes they may find themselves on the financial rocks.

As a consequence of the above conditions there is at the present time a determined effort to economize, but this is being done by postponing expenditures rather than by more efficient handling. This matter of efficiency has been sadly hampered by the actual workings of the Transportation Act covering the handling of labor. Practically all questions involving labor must be passed on by the Labor Board before they can be applied, and this process makes for slowness in making changes, which in turn does not permit the railroads to avail themselves of rapidly changing conditions. If this drawback cannot be overcome, it will be impossible to effect much economy in this particular direction and this must be the price the public must pay for reasonable stability in labor matters as affecting transportation. It might be said in this connection that in the mechanical department of the Santa Fe the men are only accomplishing 65 per cent per hour of the amount they performed before the period of government control, and the leaders of the men have openly said to us that they do not propose to work as they formerly did. The question of working rules, involving this whole matter of efficiency, is now before the Labor Board and is to that extent out of the hands of the railroads. On the other hand, the country at large is pointing to the fact that railroads are paying more for track labor than the industries alongside are paying and therefore, as they claim, more than is necessary, and they are not disposed to allow us to put this off on the Labor Board. It is my thought that we must let the Labor Board settle it, but that our duty consists in showing the Labor Board all the aspects of the question. I feel that it will be worked out along these lines.

Assuming, however, that the stormy periods of low earnings and the labor question are passed safely, there is a very serious problem ahead—namely, the financing of future capital expenditures. You, as engineers, are vitally interested in this question because on the ability of the railroads to solve it properly depends the continued employment of large numbers of engineers. The Transportation Act tried to take care of this by decreeing that the earnings of the valuation of groups of roads should be 5½%; in the next place, 5½% will not get the money; and finally, any money that can be raised will not buy the same amount as before the war. No road can afford to borrow money at above 7% and only be allowed to earn 5½ or 6%. You might stand such a diet for a short time, but as a steady thing you would find yourself growing very thin. To illustrate the seriousness of this problem, take a facility that before 1914 cost $100. The railroad had to earn and pay out to cover interest on that facility about four dollars and a half annually. Today that same facility will cost at least $200 and with money at 7½% you can readily see that there must be earned annually fifteen dollars in interest to cover identically the same thing that cost us four dollars and a half five years ago.

You may be able to realize more readily this problem if I illustrate by means of the Santa Fe. For five years prior to 1914 it expended annually for additions and betterments and equipment 20,000,000. This amount, therefore, may be

taken as representing the amount necessary to take care of the growth of the country along its lines. To provide the same enlargements today would cost over $40,000,000 a year. But, for five years we have not made the usual additions due, first, to the high prices caused by the European war; next, by our own entrance into the war; and finally, to the period of government control when all work that could be postponed was deferred to help win the war. We are, therefore, several years behind and the growth of the country meanwhile has been very much more than normal. As a minimum I should say we ought to spend twenty millions a year to catch up with these *deferred* items for a period of at least three years. This would make a total of sixty millions a year for three years, of 180 millions to be expended to put us, with relation to the business of the country, at the end of three years where we were in 1914. Apply these figures to the railroads of the country and you have the stupendous sum of 1½ billion dollars a year for three years, which should be spent and charged to capital account. This is the tremendous problem that the railroads face—namely, how to raise such very large amounts of money and at the excessive rates of interest now necessary. Until it can be done, the railroads will have to struggle to carry the load and will do it with satisfaction neither to themselves nor to the public.

I think you will recognize from what I have said that the Transportation Act has not solved all our troubles. It has made the solution of some of them possible. I can only say that in spite of the magnitude of the obstacles, I have great faith in the ultimate outcome. I believe in the ability of the American railway men and I believe in the good common sense of the American people, and that thse two forces will ultimately find the solutions of the problems I have tried to picture to you.

JOURNAL OF THE
WESTERN SOCIETY *of* ENGINEERS

Volume XXVI APRIL, 1921 Number 4

CURRENT ENGINEERING ACTIVITIES

CO-OPERATION AND CREATIVE LEADERSHIP
The Priceless Opportunity of the Twentieth Century

HERBERT HOOVER, President of the Federated Engineering Societies, Urges Engineers to Vision the Future and Unite in the Development of the Federation Movement for the Solution of Great Nation Problems, Economic and Political.

Chicago Engineers, on the evening of December 10th, received an intimate and personal message of encouragement from the profession's dominant personality—Mr. Herbert Hoover—a message as unusual as it was inspiring. The message evidently lay close to the heart of the serious and forceful leader, who came to Chicago also to plead the cause of the "Invisible Guest" of Christmastide, and he spoke with profound conviction and with obvious effect upon the group of 100 gathered at the Engineers' Club, representing the leaders of the twenty-two Technical Societies of Chicago, known as the "General Committee." This committee, convened by its chairman, Frederick K. Copeland, President of the Western Society of Engineers, upon the call of the undersigned, itself represented in a local way the Federation idea so strongly endorsed by Mr. Hoover. It was formed for war purposes and has been perpetuated as a going organization for co-operative action. This point was very happily emphasized by Mr. W. L. Abbott, vice-chairman, who presided in the absence of Mr. Copeland.

After discussing the National Federation movement, Mr. Hoover responded very generously to other questions of world interest, and with happily placed humor intermixed with the intense tragedies recalled from his personal contact with the human and economic debacle of Europe. But the burden of his message obviously lay in the opportunities now in the path of the Engineering profession for constructive, united and immediate action upon the portentous problems confronting the individual as well as the nation.

Six important and serious propositions stand out from this sympathetic message which were directed especially to those who were perhaps not in full accord with the Federation but desired first-hand information from "the man who knows."

1st. That of all the various associations of men for group interest, e. g. employer, farmer, merchant, banker, organized labor, the Engineer alone stood in a conspicuous and enviable position, with "no axe to grind" except the broad welfare of society and humanity.

2nd. That *the Engineer thinks quantitatively* and *with a weighted perspective*, hence he should speak with authority but rarely does, either as an individual or by group action, and more rarely still, in an effective way.

3rd. That the outstanding questions confronting the 200,000 men in allied technology today are labor and transpor-

tation, to which they should give their best brains and experience.

4th. That the problems of the next generation will be 99% economic, requiring the most perfect organization possible in order that the Engineer's efforts may be vocalized.

5th. That the great opportunity of the Engineer for effective co-operation is the Present; delay and vacillation may readily bring about national conditions which will be so far beyond sensible solution as to nullify the Engineer's efforts for years to come.

6th. And finally, that the Federation is in fact, as well as in principle, the first great step to this end; it is a going concern,—a constitutional measure with a great purpose and, like the Constitution of the United States, can and no doubt will be amended according to the needs and desires of the founders as expressed in the working machinery to be devised for the fulfillment of an object entirely above local or sectional interest or prejudice. If it fails in some particulars, "try again."

A fortunate and striking aspect of the message of Mr. Hoover was the open—, mind displayed in discussing the Federation's organization and the obvious intention of his administration to perfect it in every way possible, recognizing frankly the essential difference between (a) the broad enabling act and (b) the various means and instrumentalities for carrying it into effect, which can only be developed *after* the basic principle has once been established. Thus at one step, the various detailed objections to the Federation were reserved, and the great fundamental object emphasized—prompt and united action. It was perhaps this authoritative expression that constituted Mr. Hoover's most important contribution.

The preparatory work of Engineering Council was heartily commended,—for example, in its efforts to further the National Department of Public Works and the initiation of the Joint Commission on the Great Lakes-St. Lawrence Waterway, in which project Mr. Hoover has hopes. In fact, never before have the congressional leaders come to recognize so fully the value of intimate cooperation with Engineers, through representation selected by Engineering Council ,in their authoritative and unselfish contributions from experience and technical knowledge. With this excellent foundation, the future of the Federation seemed assured, providing sympathetic support is forthcoming.

Mr. Hoover stated that he had been led to accept the presidency of American Engineering Council because of the opportunity it afforded for great and good influence in coping with the growth of great national associations which is tending toward a division of the population into great economic groups. Most of these associations are inspired by a selfish motive and seek to dominate the action of legislative bodies through a "terrorism little less than sovietism," or else are attempting to bring pressure on the government in their own particular interest, regardless of the equally important interests of other groups. If this selfish purpose is allowed to continue on the part of these numerous associations it will lead to destruction. Continual conflict spells the breakdown of our entire national life. We have already come to the parting of the ways.

Mr. Hoover laid emphasis upon the point that if we are to have the influence in public life of the disinterestedness, detachment and adherence to scientific facts embraced in the engineering profession, and to keep apart from the influence of the numerous bodies having special selfish interests, we must have an organization to do it—some definite engine to perform this work.

As president of the Institute of Mining and Metallurgical Engineers, Mr. Hoover said that he had opposed the participation of this association in public matters, and had felt very strongly that it should keep to its function of developing the technical and ethical aspects of the profession. At the same time he had strongly favored going into the Federated Societies in order to provide an influential national organization of Engineers which would be so constituted as to be able to enter into the great problems facing the public and have this as its *primary* object. He considered that the movement applied as well to state and municipal affairs as to national matters.

It was very material, in the speaker's judgment, that the organization be so constituted that it will sense the sentiment of the engineers of the country before committing them to important policies, and that the big thing now is to get behind the movement and lend immediate support so that the work of the Federation may be effective during the next twelve months in the solution of the tremendous problems which we now face. This period of probation would be the most important.

During the course of his address Mr.

Hoover referred to the public regulation of public utilities and other natural monopolies. Individualism—the impulse of self-interest, is the very basis of our civilization. Regulation is simply an attempt to give a "square deal." But we have yet to devise laws that will protect the public from natural monopoly and at the same time keep this initiative. Under the present system no financial group is ready to take the responsibility of financing the necessary expansion of these monopolistic businesses. He did not want to see government ownership. While this matter of regulation is one of the great problems which the people must solve, he said that "no one in Washington has held his head in his hands ten minutes trying to solve it." On the contrary, the primary effort has been to coin phrases that would get into the headlines and pull votes.

Mr. Hoover also made a brief but sympathetic analysis of the labor problem. The American people must and will find the solution for preserving individual initiative of its citizens, either Labor or Capital, and also for their protection from all forms of destructive domination.

At present organized labor is between two fires. There is the radical element on one side, demanding the one union idea, with the object of dictating to government and the ultimate socialization of industries. But labor realizes that this cannot be attained as long as true draftsmanship is the basis of organization. In other words, it will be necessary to redesign the present structure of the labor organizations before it is possible to bring about any great change in structure desired.

On the other side there is Capital, which is being counseled in many quarters to take advantage of the present favorable situation to crush out organized labor altogether. Between these two extreme forces, Mr. Hoover said that the craft basis of organization might be crushed out and he thought it well worth while to consider the advisability of supporting this form of organization with fair collective bargaining and graded compensation. For labor will be organized in some manner, regardless of any effort to suppress it. Labor unionism, Mr. Hoover said, must undergo evolution, not revolution, must find a way to inspire employers to bring about the substitution of leadership for slave-driving without mutual destruction.

Labor is now earnestly groping for some method of altering the whole economic operation of its organizations, to get away from the principle of limited production for securing wider employment —a species of sabotage. It is now seriously proposed that every effort be put toward the problem of how to get maximum production within reasonable physical limitations. While some people would claim that this attitude of labor was insincere, he believed it was honest and considered it the greatest mental revolution we have ever seen. Mr. Hoover pointed out that the great underlying objection to the closed shop is that it has always meant less production, and he thought that if this could be changed there would be little well-founded objection to the real purposes of organized labor. Similarly, the non-union shop had its serious human dangers from unscrupulous employers. And even compulsory arbitration has also its psychological defects when the jail is the only line of direct action; for the jail is *not a cure* but only an aggravation.

Labor, Mr. Hoover contends, calls to the Engineer, desires his skill and technical experience as the best equipped and impartial mind working upon this problem. He is the "party of the third part" looking at it only from the constructive aspect. It is the Engineer's problem to devise a solution of the tremendous wastage in human as well as material values, due to the various causes of seasonal and intermittent employment from the shifting of industrial currents as well as from strikes and lockouts. This wastage is at the very bottom of this great human conception of a future sympathetic *community spirit* designed to promote production, living standards, craftsmanship and creative instinct—brains. Battle and destruction are a poor solution and a descent to barbarism a poor substitute for the keen sportsmanship of mutual understanding.

If organized labor could be brought into co-operation with organized employers we would see a tremendous advancement in industrial conditions.

This, Mr. Hoover contends, would be the priceless boon of the twentieth century. The Engineer cannot hold himself aloof. Co-operation with his fellows is the primary step.

ARTHUR L. RICE,
Member Amer. Engineering Council.
HERBERT S. PHILBRICK,
Chairman Am. So. Mech. Engrs.
GEO. M. DAVIDSON,
Chairman Am. Inst., Mining and Metallurgical Engrs.
J. R. BIBBINS,
Chairman Am. Inst. Elec. Engrs.

Chicago Safety Council

The Chicago Safety Council recently organized its Committee on Fire Prevention and has actively undertaken its work in this important field. The object of the committee is to co-operate with the Bureau of Fire Prevention and Public Safety of the Chicago fire department, the National Fire Protection Association and other organizations, to foster proper observance of October 9, the anniversary of the great Chicago fire, as Fire Prevention Day and in general to conduct activities designed to prevent fire waste and the resultant loss of life.

The committee elected T. R. Weddell, Insurance Post, chairman; J. C. McDonnell, chief, Bureau of Fire Prevention and Public Safety, Chicago fire department, vice-chairman; and Wm. S. Boyd, electrical inspector, The Union, secretary.

The Safety Council now has a total of ten committees actively engaged in the work of accident and fire prevention. During the week, meetings were held of the fire prevention, highway safety, advisory and safety supervisors' school committees.

Lewis Institute Branch, W. S. E.

On Monday, March 14, the Lewis Institute Branch of the Western Society of Engineers visited the Link Belt Company's plant at Thirty-ninth street and Stewart avenue. Arriving at the plant at 9:30, they were first shown through the pattern shop. Some of the patterns being made were unusually large and included several patterns for large gears and gear-rings, one being for the base of a locomotive crane. The two floors above the pattern shop are used for storing patterns. In the foundry the party watched the making of several large molds. In the machine shop many large machines were seen in operation. Among which were several large boring mills, drill presses, and one 72-inch radial drill. The assembly, storage and shipping rooms in connection with the machine shop were also visited. In the assembly room the party had the opportunity to inspect one of the locomotive cranes which are manufactured by this company. The party completed the visit by inspecting the new office building. The well-lighted drafting room was a feature which impressed the party very much. The trip was successful, although, because of the weather, the turnout was not as large as was expected.

HENRY VAN DYKE,
Secretary.

Utilizing Low Grade Ores

"Engineering Foundation" has issue Research Narrative Number Three unde the above title crediting the facts to M W. G. Swart, Mining and Metallurgica Engineer, Duluth, Minn.

This is the Iron Age. An Aluminu Age may follow; but its sun is far belo the eastern horizon.

Iron is essential to the present hig degree of usefulness and independenc which the United States enjoys amon the nations of the world. Necessary pr duction and improvement of iron an steel depend upon research by metallu gists, chemists, physicists, engineers, an geologists.

Each year there are consumed in th United States about 75,000,000 tons c iron ore. Methods of smelting now i vogue demand ore containing 50 per cen or more of iron. Known deposits mee ing this requirement are being rapidl depleted. To be sure, they will last man years. But what next? One answer is New deposits of rich ore may be foun in our country; but the search has a ready been diligent. If found, rich o bodies may not be advantageously si uated in respect to transportation, blas furnaces or steel mills. A second repl is: Import; there are rich ore deposit in other countries, some of which are a ready controlled by Americans. Som objections are obvious, especially in time of national defense, when iron is mos needed.

A third solution of this problem ha long been sought by scientists and i ventors.

Large sums of money have been d voted to experiments. Success at lengt seems assured. What is it? The econ mic utilization of low-grade ores. The are vast deposits of such iron ores co veniently situated as to transportatio and existing iron and steel industrie Mr. D. C. Jackling and associated eng neers, members of the American Inst tute of Mining and Metallurgical Eng neers, after exhaustive research, fo lowed by experiments on a semi-con mercial scale, have developed a practica process. Five years of hard work we necessary, in which all previous know edge was utilized, and hundreds of thou sands of dollars were spent.

Large quantities of low-grade ores a of the magnetic variety. It is to su ores that the new process applies. The are estimated to be many billions of ton These ores are to be quarried in hug quantities, crushed and ground, and the the iron-bearing particles separate

from the remainder by electro-magnetic methods. This selected portion is sintered (partially fused so as to form masses) and crushed to convenient size. A rich concentrate results, in acceptable condition for the blast furnace.

Extended experience in mining and working these lean ores will, doubtless, bring improvements, and, with continued research, great economies may be effected. This beneficiating of low-grade iron ores, so as to make them usable, must be accomplished if the United States is to continue to hold its position as a steel producer on the present scale.

The studies have not been confined to any single ore deposit. Ores from many localities have been put through the tests. Machinery and methods of great value to the iron and steel industry, as a whole, have been developed. The first unit (costing $4,000,000) of a large plant for the concentration of these low-grade ores is under construction in Minnesota. The cost of the complete plant has been put at $60,000,000; its capacity would be 100,000 tons of rock daily, yielding 40,000 tons of concentrates.

Research is sometimes costly; but wisely directed, it pays. The whole world is benefited.

S. I. E. Convention

The Society of Industrial Engineers will hold their National Convention at Milwaukee, Wis., April 27, 28 and 29, 1921.

"Industrial Leadership" will be the major subject. The tentative program as announced is as follows:

April 27—"The Responsibility of Leadership in Industry," "The Principles Upon Which Industrial Leadership Rests," "The Qualities of the Industrial Leader," "Selling the Idea of Modern Management," "How to Develop Leaders From Among the Working Force," "How to Secure Co-operation From Among the Workmen," "Industrial Leadership as a Factor in Community Development."

April 28—"Selecting the Man for the Job," "The Responsibility of the Stockholder in Industry," "The Engineer in Industrial Leadership."

April 29—"Practical Methods of Fatigue Elimination," "Rate Setting and Instruction Cards," "Planning Boards and Charts," "Practical Methods of Testing Applicants for Jobs," "Methods of Determining a Fair Day's Work and a Fair Day's Pay," "Coordination of the Personnel and Production Departments," "How Can the Workman Participate in Management?"

The Annual Dinner will be held Friday evening, April 29, 1921.

American Engineering Societies

The offices of the Federated American Engineering Societies were moved to the National Savings and Trust Company Building at 15th street and New York avenue, on March 21. A suite of eight rooms has been leased on the third floor which in addition to the regular executive offices will contain rooms for the use of members of all constituent organizations with such special facilities as they may want placed at their disposal. This is to be the Washington Home of Engineers and the Executive Secretary is anxious to have suggestions as to how it may be made of the greatest utility to members.

PERSONAL NOTES

Montford Morrison, M. W. S. E., has resigned his position as Research Engineer of the Victor Electric Corporation, Chicago, to accept a position with the International Devices Company, 326 Broadway, New York City.

C. M. Emerson, M. W. S. E., Assistant General Sales Manager, Standard Conveyor Company, with offices in Chicago, has been transferred to the New York office of the same company.

Ira Dye, A. W. S. E., has resigned his position as Superintendent of the American Frog and Switch Company at Hamilton, Ohio, and has opened offices at 430 Lumber Exchange, Seattle, Wash., for the practice of Industrial Engineering in the Puget Sound district.

Gunni Jeppesen, M. W. S. E., formerly Chief Engineer of the Strauss Bascule Bridge Company, has joined the Chicago Bascule Bridge Company as As-

sociate Engineer. Mr. Jeppesen, who is a graduate of the State Polytechnical Institute at Copenhagen, Denmark, was connected with the Strauss company for twelve years, from its inception until 1917, and since then has been engaged in industrial plant work as Structural Engineer, Leonard Engineering Co.

Edward Haupt, A. W. S. E. and Vice-President of the Building Construction Employers' Association for several years, was recently elected president of the latter organization.

COMMITTEE PROGRESS REPORTS

DEVELOPMENT COMMITTEE

E. T. HOWSON, Chairman

After months of careful thought and study the Development Committee prepared a questionnaire which was sent to the membership. The subjects covered concern practically all phases of the Society's activities—Meetings, Papers, Publications, Sections, Committees, Quarters, Library, Civic Activities and Public Affairs, Inspection Trips, Employment, and Affiliation and Co-operation.

Up to the present time about four hundred of these questionnaires have been received back in the Secretary's office. The Committee hopes to meet again in the near future to tabulate the information and in order that the answers be representative of the membership of the Society, it is urged that those who have not yet sent in their questionnaires, do so promptly.

EXCURSION COMMITTEE

CASS KENNICOTT, Chairman

About one hundred members of the Society and their friends took advantage of the opportunity to see the stockyards on March 22, when the Excursion Committee, through the courtesy of Morris & Company, made an inspection trip to the latter's plant.

The morning was taken up in visiting the killing, dressing, cooling and storage sections, including the manufacture of fertilizer, glue, hair curing, lard, etc.

Luncheon was served at the Company's restaurant, after which the party inspected the pickeled meat, storage canning and smoked meat departments, including the general office system.

A special train was provided by the Elevated Railways which took the party to the yards. While the party was not large those who attended were well repaid for the trip.

INCREASE OF MEMBERSHIP COMMITTEE

C. W. PEN DELL, Chairman

Recently there was mailed to each member of the Society an application blank and extracts from the Constitution. The purpose of this was two-fold: First, to urge those who are Associate, Junior or Student Members to apply for the next higher grade to which they are eligible. Second, for all members who have no need to transfer to another grade to request them to pass the application to some one of their engineer friends or associates who is eligible for membership in the Western Society of Engineers.

The results of the interest in the above are already apparent and the Increase of Membership Committee is working to the end that we may have a bigger and better and a more representative Society each succeeding year.

MILITARY COMMITTEE

MURRAY BLANCHARD, Chairman

Three hundred twenty-seven replies have been received from members in response to the questionaire on "Plans for Essential Preparedness." Opinions are expressed quite fully but a few only are willing to join the National Guard. Considering, however, the number who are now in the Reserve Corps and those who are willing to join the Reserve Corps or the National Guard the answers indicate that about one-half are favorable.

The replies are as follows:

	YES	NO
1. Do you favor Universal Military Training?	281	46
2. Do you favor National Guard Training?	257	52
3. Will you be favorable to and assist in organizing an Engineer Regiment Illinois National Guard?	187	66
4. Will you join an Engineer Regiment, Illinois National Guard?	40	202
5. Do you favor a plan of preparedness so that the material and personal resources of this country can be promptly mobilized?	300	3
6. Are you a member of the Reserve:		
(Army)	46	..
(Navy)	15	..
7. Will you join the Reserve Corps?	59	150

Suggestions were asked under question 5 and the following recommendations have been made:

Index and inventory, all industries.

Government control of railroads, public utilities and essential industries.

A census each five years to obtain data relative to resources and personnel for war purposes.

Teach loyalty in the schools.

Provide military training in the high schools.

Train reserve corps in all universities.

A regular army of 500,000.

Mobilize all the men for military training.

Universal conscription in time of war.

Establish a post graduate course at West Point in modern war and diplomacy.

Organization of a construction corps.

A general staff for an army of thirty corps.

Establish a permanent Bureau of Transportation.

Extend and improve highways.

Experimental work in aviation, ordnance and engineering to be carried on in a large scale.

Increase the aviation service.

Have a navy equal to any in the world.

Subsidize merchant marine.

NOONDAY LUNCHEON COMMITTEE

BENJAMIN WILK, Chairman

In addressing the Noonday Luncheon Meeting, Friday, March 11, on "A Basis For Business Revival," Charles R. Holden, Vice-President of the Union Trust Company, pointed out that the financial effects of the war would have to be taken into consideration in industry for a number of years. The high cost of money must be reflected in the cost of products.

In order to make business profitable, it is necessary to figure not only the actual cost of labor and materials, but also a higher rate of return because of increased taxes.

Mr. Holden referred to several schemes for reviving business and pointed out that faith in the stability of the government, and an interest in the government must be taken by the general public.

Dr. Marion Leroy Burton, the new President of the University of Michigan, will address the Noonday Luncheon Meeting at the Morrison Hotel Friday, April 8. President Burton is one of the leading educators in the United States, and before accepting the presidency of the University of Michigan was President of the University of Minnesota for several years.

Get the W. S. E. luncheon habit.

PROGRAM COMMITTEE

G. A. HAGGANDER, Chairman

The Program Committee has been holding monthly meetings in order to make definite arrangements for papers at least one month in advance of presentation. This has been necessary on account of the printing of the program for the whole month at one time. It has had a very desirable effect in forcing the making of definite arrangements in advance. There have been practically no substitute speakers or papers.

The great need of the Program Committee at the present time is the assistance of the members of the Society in securing interesting subjects or speakers. The present Committee has already arranged for 80 meetings and have 20 more before a new Committee is appointed. Consequently the subjects and speakers obtained through the personal efforts of the members of this Committee have been almost exhausted. The general meetings

have been especially hard to arrange for, and we will gladly accept suggestions from the membership at large, both for general and section meeting programs.

YOUNG MEN'S FORUM

BENJ. B. SHAPIRO, Chairman

In February, the Young Men's Forum and its chairman were reported among the obituaries of the Journal. The March Journal had us associated with them, but strange to say although supposedly demised, they are very much alive, more so than ever. This can readily be seen by the subjects that were presented and discussed during February and March and what is announced for April. On March 12th Mr. Dee, of the S. W. Strauss & Co., discussed financing of Building Construction, and the discussion of same was lengthy and instructive. March 26th the questions of specifications by F. J. Thielbar, M. W. S. E., was presented in such a manner that very little was left of the Why! What! and Wherefore of them.

April meetings are in line with the natural thought of the day. April 9th Real Estate Loans will be presented by Mr. Edgar N. Greenebaum, of Greenebaum Sons Bank and Trust Co. This will cover the entire field from its first inception until the last payment is made.

April 23rd will be the first of meetings on the Engineer in Perspective. Mr. Meyer Fridstein, M. W. S. E., will talk on "The Future of the Engineer, How It Affects You." How many can you bring with you to these meetings? Your friends are just as welcome as you are yourself.

LIBRARY SERVICE

E. V. SAVAGE, Librarian

INDEXES TO ENGINEERING LITERATURE

The availability of the literature upon any subject is largely dependent upon the indexes to that material. For the engineer there are two general indexes to the matter which is appearing currently in the technical press—the Engineering Index and the Industrial Arts Index. These indexes are not only valuable because they make currently available this engineering information but because they become manuals of engineering practice extending over a period of years.

The Engineering Index covers a period from 1884 to date. With the exception of the first four volumes, the material has not been cumulated but is listed in yearly volumes.

Published now by the American Society of Mechanical Engineers, it appears monthly in the issues of Mechanical Engineering.

Information from about 1200 technical publications is included. A short annotation gives a clue as to the scope of each article. The adoption of the alphabetic-subject arrangement in 1919 greatly facilitates the use of this index.

The Industrial Arts Index covers the period from 1913 to date. It indexes about 150 technical journals as well as government and other bulletins falling within its scope. The thorough indexing, careful selection of subjects and cross references and the inclusion of all articles make this index an invaluable aid. It appears ten times during the year and cumulates quarterly.

For an earlier period, 1883-1892, some useful references to material of historical interest may be found in Galloupe's General Index to Engineering Periodicals.

Science Abstracts (Section B) published by the Institution of Electrical Engineers, lists, in the form of abstracts, information on electrical engineering. References are made to British, American, French and German literature. It is issued monthly and covers the period 1903 to date.

An index covering a different field but containing much of value for the Engineer is Chemical Abstracts published by the American Chemical Society. Such subjects as cement, building materials, sewage, fuels, petroleum, chemical engineering, metallurgy, etc., are included. Reference is made to books and to patents. An abstract of each article is given and this is frequently of such length that the information may be obtained without consulting tne original article. It is published semi-monthly with the last issue of the year an index number for the year. A cumulated index has been published for the period 1907 to 1916.

Revue de L'Ingenieur et Index Technique, beginning in 1903, is a monthly index containing also general reviews of articles with references to both journals and books.

Repertorium der Technischen Journal Literatur and its successor, Fortschritte der Technik, cover a period from 1874 to 1910.

An English periodical which is an index of modern developments is the Technical Review. Its title reads "a weekly summary of development and progress throughout the world." The material is abstracted in articles of varying length.

In view of the small number of general indexes available, considerable dependence can be placed on the indexes of individual periodicals and of the proceedings of technical associations. Very good work has been done in indexing those of some of the foreign countries. These will be necessary in making a thorough search.

The Engineering News has an index from 1874 to 1917. The valuable material in the Proceedings of the Institution of Civil Engineers is indexed from 1837 to 1907. The American Society of Civil Engineers—Transactions are indexed from 1867 to 1911. Transactions of the Society of Engineers are indexed from 1857 to 1909. Le Genie Civil has been indexed from Vol. 1 to 60, 1880 to 1912. Somewhat related are the Proceedings of the Institution of Municipal and County Engineers for which there is an index covering the years 1873 to 1904. Both the Association of Water Engineers and the New England Water Works Association have indexes—the former covers the years 1896 to 1919, the latter from 1882 to 1915. The Journal of the Royal Sanitary Institute is indexed from 1876 to 1900.

The yearly Municipal Index published by the Municipal Journal was a very useful compilation but only covers the years 1912 to 1917.

In the division of mechanical engineering, the American Society of Mechanical Engineers—Transactions are indexed from 1880 to 1904; The Institution of Mechanical Engineers — Proceedings from 1874 to 1910.

For the electrical engineers, the American Institute of Electrical Engineers has its material indexed from 1884 to 1910, the Institution of Electrical Engineers from 1872 to 1911, the National Electric Light Association from 1885 to 1909. Of the periodicals, the Electrical World is indexed from 1883 to 1908.

In the field of gas engineering the American Gas Institute (now American Gas Association) has done some good bibliographic work. The proceedings are indexed from 1906 to 1915. The Bulletin of Abstracts is a useful index to the literature of the subject.

Under the heading of mining engineering the American Institute of Mining and Metallurgical Engineers has indexed its Transactions from 1871 to 1918, the Institution of Mining and Metallurgy from 1892 to 1906, the Institute of Mining Engineers from 1889 to 1918. The Mining World Index of Current Literature covers the years 1912 to 1916. W. R. Crane has compiled an Index to Mining Literature from 1909 to 1912. The Journal of the Iron and Steel Institute is made available from 1869 to 1910. A number of local societies of mining engineers have indexed their proceedings.

The American Railway Engineering Association index bears the dates 1900 to 1915; the American Railway Master Mechanics' Association, 1868 to 1900. The Street Railway Journal has an index from 1884 to 1903. Revue Generale des Chemins de Fer et des Tramways is indexed from 1878 to 1910.

Other indexes extending over a period of years which prove helpful as a key to the literature of a special subject are those of Institution of Automobile Engineers, American Electrochemical Society, American Society for Testing Materials, Franklin Institute, Institution of Naval Architects, Institution of Engineers and Shipbuilders of Scotland, American Society of Naval Engineers, United States Engineers Reports, etc., etc.

A few local societies, as the Engineers Society of Western Pennsylvania, Canadian Society of Civil Engineers, Western Society of Engineers have published indexes.

The question of where to find a list of the books published in this country upon a certain subject can be answered most easily by the United States Catalog Series published by the H. W. Wilson Co. Volume 1 contains the books in print January 1, 1912. Volume 2 contains the books published from 1912 to 1917. Supplements bring this record down to the current year for which the source of information is the Cumulative Book Index which is issued monthly, except August.

The current source of information concerning the publications of the United States government is the Monthly catalogue of the United States Public Documents issued by the Superintendent of Documents. This is also the source of the monthly list of state publications.

This prosaic list of indexes is given in the hope that it may open up the possibilities for source material in engineering literature. For extensive research much more information is available.

FROM THE SECRETARY'S OFFICE

Edgar S. Nethercut, Secretary

Amendments to the Constitution

To the Corporate Members:

Notice is hereby given that at the first regular meeting in April, which will occur Monday, April 4, 1921, at 7:00 p. m., the amendments to the Constitution which were presented at the meeting held March 7, 1921, will be in order for discussion and amendment under Article XV of the Constitution, which reads as follows:

"Sec. 1. Proposed amendments to the Constitution shall be submitted in writing and must be signed by not less than twenty-five Corporate Members.

"Sec. 2. Amendments presented to the Society on or before the first regular meeting in March shall be printed and mailed to each member at least fifteen days before the first regular meeting in April. Such amendments shall be in order for discussion at the first regular meeting in April, and may be amended in any manner pertinent to the original amendments by a majority vote at that meeting, after which they shall be voted upon by letter ballot, the vote to be counted at the first regular meeting in May.

"Sec. 3. An affirmative vote of two-thirds of all ballots cast shall be necessary to the adoption of any proposed amendment. Amendments so adopted shall take effect at the next Annual Meeting."

No change is proposed in the entrance fees. The proposed amendments are as follows:

A ARTICLE V.

FEES AND DUES.

Amend Section 1 to read as follows:

"Sec. 1. The entrance fee and annual dues for the various grades of membership in the Society shall be as follows:

	Entrance Fee	Annual Dues Resident	Non-Resident
Honorary Member...	None	None	None
Member	$15.00	$20.00	$15.00
Associate Member....	12.50	16.50	12.50
Affiliated Member....	12.50	20.00	15.00
Junior Member......	5.00	10.00	6.50
Student Member.....	1.00	2.50	2.50

"From each of these annual dues $2.00 shall be set aside as subscription to the Journal.

"On transfer of a member to a higher grade, the entrance fee previously paid by him shall be credited against his entrance fee to his new grade."

ARTICLE XV.

AMENDMENTS.

Amend Article XV. to read as follows:

"Sec. 1. Proposed amendments to the Constitution shall be submitted in writing, and must be signed by not less than twenty-five Corporate Members and filed with the Secretary.

"Sec. 2. Amendments shall then be presented at the next regular monthly meeting of the Society. After such monthly meeting the proposed amendments shall be printed and mailed to all members of the Society at least fifteen (15) days prior to the next monthly meeting, at which meeting the amendments shall be in the order of business for discussion and may be modified in any manner pertinent to the original amendments by a majority vote of the members present at such meeting.

"The amendments as thus revised shall then be voted upon by letter ballot, which ballot shall be due and counted within thirty days after such meeting.

"Sec. 3. An affirmative vote of two-thirds of all the ballots cast shall be necessary for the adoption of any proposed amendments. Amendments so adopted shall take effect at the next annual meeting, unless the amendment is accompanied by a resolution providing that it shall take effect at an earlier date."

Nominations

The fiscal year begins June 1st. The Constitution and the Rules of the Sections provide for nominations for officers for the ensuing year at this time. Reports from Nominating committee so far are as follows:

NOMINATIONS FOR OFFICERS OF THE WESTERN SOCIETY OF ENGINEERS

Regular Ticket

President—Charles H. MacDowell.
First Vice-President—Julius L. Hecht.
Sec. Vice-President—Frank F. Fowle.
Third Vice-President—Benjamin B. Shapiro.

Treasurer—Homer E. Niesz.

Trustee for Three Years—E. W. Allen.

For Members of the Washington Award Commission for Three Years—Prof. John F. Hayford, Henry J. Burt.

Presented to the Board of Direction at its meeting held March 21, 1921.

NOMINATING COMMITTEE.
C. C. Brooks, Chairman.
J. A. Dailey, Secretary.

Additional nominations may be made by petition as provided in Article VII., Section 7, of the Constitution.

"Additional nominations for any office provided for in Section 5 of this Article may be made by petition, provided such petition is accompanied by an acceptance of the nomination signed by the nominee if filed with the Secretary of the Society before the 20th day of April, and further provided that each petition shall be signed by at least twenty Corporate Members. Nominations made in accordance with this Section shall be known as the Ticket by Petition."

Biographical sketches of the nominees appear on pages 90, 91 and 92.

SECTION OFFICERS

Mechanical Engineering Section

Chairman—G. R. Brandon.

Vice-Chairman—Alex D. Bailey.

Director, Three Years—Jas. D. Cunningham.

Election to be held April 18th.

Gas Engineering Section

Chairman—R. B. Harper.

Vice-Chairman—C. W. Bradley.

Director, Three Years—H. E. Bates.

To fill vacancies:

Director, Two Years—H. H. Clark.

Director, One Year—W. M. Willett.

Election to be held May 11th.

Hydraulic Sanitary and Municipal Engineering Section

Chairman—L. R. Howson.

Vice-Chairman—Paul E. Green.

Director, Three Years—John A. Dailey.

Election to be held May 2nd.

Through the courtesy of one of our members, we have a number of the publications of the A. I. E. E. and the A. S. M. E., which will be given to those of our members who will be interested in the same.

Apply to the librarian.

In accordance with the instructions of the Board of Direction and the rules of the Robert W. Hunt Award as approved by the Board of Direction and published in the Journal of the Society in January, 1921, I wish to advise of the appointment of a Committee on the Robert W. Hunt Award the following:

Chas. W. Gennet, Jr., M. W. S. E., Chairman.
L. E. Ritter, M. W. S. E.
Prof. A. N. Talbot, M. W. S. E.
Theodore W. Robinson.
Robert P. Lamont.

(Signed) F. K. COPELAND,
President.

Rules of the Section

It has been necessary to amend the Rules of the Sections in order to comply with the change of the fiscal year from January 1st to June 1st. This affects Section Seven. Petitions have been prepared amending this section so as to read:

Sec. 7. The Chairman, Vice-Chairman and one Director shall be nominated at the next to the last regular meeting of the Section in the fiscal year and a list of the nominees posted on the Bulletin Board in the Society Rooms. Other nominations may be made by petition signed by ten members of the Section, provided such petition is posted on the Bulletin Board in the Society Rooms for at least two weeks preceding the election. They shall be elected by ballot at the last regular meeting of the year. The retiring Chairman and Vice-Chairman shall not be immediately eligible to re-election to their respective offices. The term of office shall begin on the *first* Wednesday in *June*. In the first election the officers shall serve until the following annual meeting of the Western Society of Engineers or until successors are installed. Ten members shall constitute a quorum at the annual election.

Note: Amendments are italicized.

ALBERT H. WOLF

Albert H. Wolf, Consulting Engineer, died suddenly on March 13, 1921, at Atlantic City, N. J., where he had gone with Mrs. Wolf only a few days previous. Mr. Wolf was born August 16, 1855, at Woodville, Miss., and came to Chicago in 1863. With the exception of a few years spent abroad in study he was prominently identified with the engineering profession until his retirement from active practice in 1914. Mr. Wolf was a member of the American Institute of Mining Engineers and a member of the Western Society of Engineers since December 30, 1890.

Charles H. Mac Dowell, M. W. S. E. Nominee for President, W. S. E.

Born Lewistown, Ill., October 21, 1867; educated Lewistown schools, short business course Wesleyan University, Bloomington, Ill. Honorary degree Doctor of Science, University of Pittsburgh.

From 1884-1887 court reporter.

1887 entered service Armour & Co., as stenographer-secretary to Philip D. Armour.

1894 organized Fertilizer By-Products Department of Armour & Co.

1910 incorporated Armour Fertilizer Works.

1910-1917 President and Director of Armour & Co., Garfield National Bank, New York.

From 1917 to 1918 Director, Chemicals Division, War Industries Board.

1919 member, American Commission to Negotiate Peace, Paris. Witnessed signing of treaty. Active in development phosphate and potash mines. Has directed extensive research in packing house by-product and agricultural chemical lines.

Member: American Institute of Mining and Metallurgical Engineers; American Chemical Society; American Association for the Advancement of Science; President, National Fertilizer Association, 1904-1905 and again 1921.

Member: Union League, Saddle and Sirloin and Glen View Clubs, Chicago; Bankers' and Whitehall clubs, New York; Columbia Country Club, Washington.

CHARLES H. MACDOWELL

Member Washington Award Commission.

Chevalier, Legion of Honor, France.

Commander, Crown, Belgium.

Knight, Crown, Italy.

J. L. Hecht, M. W. S. E. Nominee for 1st V-Pres., W. S. E.

Born Chicago, May 6, 1875.

1904 graduated from Massachusetts Institute of Technology, degree S. B.

1895-1897, machinist, Chicago Edison Company.

1897-1900, inspector, construction and installation work, Commonwealth Electric Company.

1905, Construction Engineer, North Shore Electric Company.

1907, Mechanical Engineer in charge of stations.

1909, Superintendent of Electrical Production.

1921, Assistant to Vice-President, Public Service Company.

Member American Society of Mechanical Engineers.

President National District Heating Association.

Second Vice-President, W. S. E., 1920-1921.

J. L. HECHT

Frank F. Fowle Nominee for 2nd V.-Pres., W. S. E.

Born San Francisco, California, November 29, 1877; educated Boston Public Schools, graduate of Massachusetts Institute of Technology, B. S., Electrical Engineering, 1899.

Experience: American Telephone and Telegraph Company, Receiver of Central Union Telephone Company, Editorial

Staff of the Electrical World, Editor-in-Chief of the Standard Handbook for Electrical Engineers. Consulting Engineer under the firm name of Frank F. Fowle & Co., Electrical and Mechanical Engineers; successor to Fowle & Cravath, which became inactive Nov. 1, 1920.

Treasurer W. S. E., 1920-1921.

Member A. I. E. E. and Manager.

Member I. E. S.

Member N. E. L. A.

Member Chicago Engineers' Club, New York Engineers' Club, and University Club of Chicago.

F. F. FOWLE

Benj. B. Shapiro, M. W. S. E. Nominee for 3rd V.-Pres., W. S. E.

Born Chicago, Illinois, September 15, 1888; educated University of Illinois, 1910, B. S. in Civil Engineering.

1911-1915, associated with the Worden Allen Company, Milwaukee, Wis.

1915-1921, Structural Engineer with Holabird & Roche, Architects, Chicago.

January 1, 1921, in business for himself as Structural Engineer, 615 Peoples Trust & Savings Bank Building, Chicago, Ill.

Secretary and Vice Chairman, Increase of Membership Committee, 1917-1920.

Chairman Young Men's Forum, 1920-1921.

BENJAMIN B. SHAPIRO

E. W. Allen, M. W. S. E. Nominee for Trustee, W. S. E.

Born Buchanan, Virginia, November 8, 1880; educated Virginia Polytechnic Institute, 1910, B. S. Electrical Engineering.

1901-1903 Testing Department, General Electric Co., Schenectady, N. Y.

1903-1911 Engineering Department, General Electric Co., Schenectady, N. Y.

1911-1913 District Engineer, General Electric Co., Chicago, Ill.

April, 1917, commissioned Captain of Infantry Officers' Reserve Corps, U. S. Army.

September, 1917, captain 341st Infantry, U. S. Army.

January, 1918, Major 341st Infantry, U. S. Army.

February, 1919, on duty with War Damage Board of American Mission to Negotiate Peace, as Chief Engineer of

EDWIN W. ALLEN

Belgian Mission.

April, 1919, mustered out of service.

May, 1919, returned to Chicago with General Electric Company, as Assistant District Manager and District Engineer.

Chairman Electrical Engineering Section W. S. E., 1917.

Member Washington Award Commission.

Member American Institute of Electrical Engineers.

Member Engineers' Club, University Club of Chicago, Glen View Club.

HOMER E. NIESZ

Homer E. Niesz, M. W. S. E. Nominee for Treasurer, W. S. E.

Born at Canton, Ohio, January 22, 1868; graduated from Mount Union College, 1886, degree Ph. B.

1888, entered service of Chicago Edison Company, and soon after appointed Assistant Superintendent of Construction.

1899, Assistant to General Superintendent and later assistant to Second Vice-President.

1909, Manager Cosmopolitan Electric Company of Chicago.

1913, Secretary of Advisory Committee Commonwealth Edison Company.

1919, Assistant to Vice-President in charge of Contract, Operating, Construction and Electrical Departments.

1921, Manager of Industrial Relations.

Member American Institute Electrical Engineers, Illuminating Engineering Society, National Electric Light Association, Ohio Society of Chicago, Chicago Association of Commerce, Industrial Relations Association of America, National Safety Council. Chicago Athletic Club, South Shore Country Club, Chicago Engineers' Club and Electric Club of Chicago.

Member Finance Committee W. S. E. 1920-1921.

Patent Office Relief Bill

The Board of Dirertion at the February meeting passed the following resolutions, which was forwarded to the Senators and Congressmen from Illinois:

To the Senators and Members of the House of Representatives from the State of Illinois:

I am directed by the Board of Direction of the Western Society of Engineers to transmit to you two resolutions passed by the Board of Direction at its meeting held February 21, 1921.

EDGAR S. NETHERCUT, *Secretary.*

RE NOLAN PATENT OFFICE BILL NO. 11984.

WHEREAS, The Joint Conference Committee of the Senate and House of Representatives having reported and agreed upon this bill.

WHEREAS, Such agreement was in accordance with the recommendation by the Patents Committee of the American Engineering Council. And

WHEREAS, The needs of the Patent Office demand immediate relief. therefore be it

RESOLVED, That the Board of Direction of the Western Society of Engineers urge the Senator and Congressman from the State of Illinois to do all that can be done to secure the enactment of the Nolan Patent Office Bill (H. R. 11984) at the present session of Congress.

RE HOUSE BILL NO. 15662.

WHEREAS, The International Convention of Paris, of March 20, 1883, to which the United States is a party, provides that if an inventor shall file his applications for patent in any of the treaty countries foreign to him within one year after his application has been filed in his own country, when the said foreign applications shall be given the same effect in contents with other inventors and in overcoming alleged prior public uses as if the said foreign applications had been filed simultaneously with the one in his own country; and as the war has prevented many inventors from filing applications in countries foreign to their own within the said one year after their domestic applications, the Peace Treaty and the Berne Convention of June 30, 1920, have extended the time within which to file such applications and to pay fees and take other steps in the prosecution of such applications which were filed or would have been filed during the war without loss of rights; and as many hundreds of applications have been filed and belated fees paid by American citizens in European countries which are parties to said latter convention, and have been accepted by those countries on the supposition that the United States would pass reciprocal legislation; and as the failure to pass such legislation will result in the invalidation of all such applications and payments of fees; and

WHEREAS, Nolan Bill (H. R. 15662) is a bill for that purpose which has been favorably reported by the Patent Committee of the House of Representatives after extensive hearings, which bill protects American citizens from undue effect of filing of applications for patent here by foreign inventors, by reserving a license under any patent granted or validated by reason of the said Act to any American citizen, who, before the passage of the Act, were *bona fide* in possession of any rights in patents of applications for patents which con-

flict with any of said patents, and also by preserving to any citizen of the United States, his agent or successors in business, the right to continue manufacture, use or sale commenced before the passage of such Act by such citizen, even though such manufacture, use or sale might infringe a patent granted or validated by reason of the Act; therefore,

Be It Resolved, That the Western Society of Engineers consider that it would be ad advantage to the inventors of the United States and their assigns and an act of justice to the inventors of the allied countries to have the Nolan Treaty Patent Bill (H. R. 15662) enacted into law, and that it should be so enacted at the present session of Congress, and the Western Society of Engineers therefore strongly urge that such action be taken by Congress.

The appeal met with favorable response from most of our Congressmen. House Bill 15662 was passed and approved by the President. The Relief Bill (H. R. 11984) was opposed and did not come to a vote.

The American Engineering Council of the Federated American Engineering Societies will seek at the opening of the special session of Congress to have the Nolan Patent Office Bill passed.

Failure of the measure in the last session is attributed to the presence of the Federal Trade Commission section which Edwin J. Prindle, of New York, chairman of the American Engineering Council's Patent Committee, in a report to L. W. Wallace, executive secretary of the Council, asserts should not be enacted into law in any form even as a separate bill. The Committee report states its belief that this is a dangerous measure in itself and will open up a most unfortunate activity for the government.

"The bill for the imperatively necessary relief of the Patent Office, after passing the House of Representatives with satisfactory provisions for the Patent Office, failed to pass the Senate at the session just closed with those same provisions, solely because of the presence in it of an unrelated section known as the Federal Trade Commission Section," says the report.

"The former opposition in the Senate to the Patent Office relief and that which forced the unacceptable reductions in salaries and numbers of examiners and clerks (which the Conference Committee was persuaded to set aside) is largely and seemingly almost wholly overcome. But the opposition in the Senate to the Federal Trade Section is determined and has expressed an intention to prevent the Patent Office from getting the desired relief, unless the Federal Trade Section is removed from the bill.

"More than preventing the Patent Office relief, however, the Federal Trade Section is believed to be a dangerous measure in itself. It provides that the Federal Trade Commission may receive assignments of and administer inventions and patents from governmental employes and is an entering wedge for further legislation to empower the Trade Commission to receive patents from non-governmental inventors or owners.

"An exclusive license would have to be granted, at least for a few years, to induce any one to undertake the almost always necessary development expense, and the Trade Commission would surely be charged with favoritism in granting such a license. In order to protect its licensees, the Trade Commission would have to sue infringers, a most unfortunate activity for the government. The industries would close their doors to the government employes fearing to disclose to them their secrets or unpatented inventions, and research by the industries would be discouraged for fear that government employes, using government facilities, might reach the result first and patent it.

"The Trade Commission, owning a large body of patents, in case that one of its patents was found to be infringed during or at the close of a frequently very expensive development by private interests would be able to dictate in the license the price at which the article, which was the object of the development, could be sold, or to dictate other similar conditions, thus depriving the development of much of its value; and could even require the licensee, as a condition for granting the needed license, to practically destroy some of its unrelated patents, as by licensing the trade generally when it would prefer to retain the monopoly for itself.

"The foregoing and other objections would result in making patents less desirable to own or to purchase, and consequently would decrease the incentive to produce inventions, which production is the main purpose of our patent system.

'The proposed section is unnecessary for the protection of government employes, since they now have all the rights which non-governmental employes have to patent inventions and to sell them. It is therefore believed that the Federal Trade Commission section should not be enacted into law in any form, even as a separate bill."

This bill contains a method of relief which is necessary to the existence of the Patent Office. The members of the W. S. E. can do a service by endorsing action to your Senator or Congressman.

Build Your Own Home

Cannot the Engineer benefit himself and the community at the present time by taking steps to build for himself a home?

This question is asked in a very serious manner. Rents have gone up so high that there is almost universal complaint. The high rents are possible because of the scarcity of houses and houses are scarce because to a certain extent, people have got in the habit of renting rather than owning. It is said that the landlords are boosting rents and this is possibly so, but it is not the landlords who are doing all of this boosting. It is a class of people who are just naturally lazy and who, when they finish their day's work in their business, do not like to obligate themselves to home responsibility. They recognize that if they owned their own homes there would be occasional odd chores around the place that they could do and possibly if they had a desire to own and maintain a home they would be called upon to shake the furnace occasionally and shovel the snow once in a while, all of which is distasteful to many people who are clamoring for apartments.

While the cost of materials and labor may be high at the present time compared with 1914 prices, the fact remains that the comparison should be made with prices which will obtain five or six years in the future, rather than five or six years in the past. There will be, without doubt, reduction in prices, but not a return to former prices. Therefore, the value of the property will not seriously be affected by a decline in prices. On the other hand it is reasonable to suppose that real estate can be found which will increase in value and probably make up, or exceed, the shrinkage due to declining prices. At least it is safe to say that if planning for construction is undertaken now and carried on in an economical manner there will remain a value which will protect the investment. In the meantime the citizen who is willing to do some of his own work in maintaining his property will be ahead of the person who will assume no responsibility in matters of this kind.

It seems as though this would appeal particularly to the Engineer, and since conditions of employment are not satisfactory just at the present time, why not do a little planning? Why should not the Engineer draw his own plans, specifications, let his own contract and superintend the construction? If he will go out into one of the number of suburbs which have not been so highly developed as to have high real estate values, be willing to walk a few blocks, and be a sort of pioneer, he will be able to make a good investment, be a good citizen, preserve his health, and in the end be considerably ahead of that lazy citizen who wants the landlord to do everything and who objects when the landlord has a chance to make him pay the price for the same.

There was an editorial in "Good Housekeeping" not long ago which is well worth reading. In part it is as follows:

"We are individualists. We do things because we want to do them, because we need to do them, because we get a profit out of doing them. If my town needs five, or ten, or a number of houses, I won't build one of them for the good of the town, but because I need it or can build it at a profit. The whole matter resolves itself, then, into a problem for individual solution. If you want a house, build it. Don't wait for the community to build it. It won't do it. And don't wait for the speculative builder to build it. He can't. He has no money; he never did have any. He used to be able to borrow eighty or ninety per cent of the cost of the building. Now he can borrow barely fifty per cent, and having no capital to span the gap between the mortgage and the cost of the building, he can't build. And don't wait for the capitalist to build your house. He wants a bigger profit than legislatures are inclined to allow him, and so he will put his money where the laws do not trouble him and their millions are at rest. If you want a house, don't depend upon any one but yourself; dig in and build it. Now is the time to study plans, to make decisions, to bring dreams to reality, to say 'I'll do it.' Everything to make a house—bricks, lumber, cement, hardware, labor—is coming down. Houses should be going up."

Good Engineering English

The following paragraph is taken from a technical paper recently presented:

"For direct current, 230 volts is beyond doubt the best for power. For three phase current, 220 and 440 volt motors are both used and the majority of the induction motors manufactured can be reconnected for either voltage. For a good-sized shop the cost of copper wire for power circuits is a large item and if 440 volts is used instead of 220, the circuit wires will be half the size, and feeders, when the voltage drop determines the size, can be one-fourth the size. For this reason 440 volts is recommended for a standard."

Should you be interested in good English try to re-write this paragraph in a satisfactory form.

The author of the paper containing this paragraph indulged in a common error by using one phrase many times. On one page the phrase, "in the case of," was repeated five times, twice in one sentence. Throughout the paper the word "cases" is used in place of the word "instances."

The questions naturally arise, "What is our pet phrase, and are we using good English?" Exactness in mathematics and carelessness in words do not indicate a well-balanced education.

MEMBERSHIP MATTERS

NEW MEMBERS

At the meetings of the Board of Direction, held February 21 and March 21, 1921, the following new members were elected:

1 Rector Egeland, 928 N. Le Claire Ave., Chicago..........Transfer—Associate
2 S. H. Ingberg, Garrett Park, Md..........................Transfer—Member
3 Walter Painter, 211 N. Grove Ave., Oak Park, Ill........Transfer—Associate
4 Victor LeRoy Fixen, 1105 Mallers Bldg., Chicago, Ill.................Member
5 Alfred Gould, 1904 N. Clark St., Cihcago, Ill.........................Member
6 Geo. D. Hardin, 3139 Indiana Ave., Chicago, Ill......................Member
7 Roy E. Rice, Noblesville, Ind..Affiliate
8 Kahn D. Thrasher, I. C. R. R., Chicago, Ill..........................Associate
9 Paul Kircher, 7332 Luella Ave., Chicago I,ll.........................Member
10 Thos. F. Montgomery, 7363 N. Ashland Blvd., Chicago, Ill...........Associate
11 A. D. Ferguson, 2624 W. Lake St., Chicago, Ill.......................Member
12 Chas. Wm. Chapman, 309 E. 59th St., Chicago, Ill..................Member
13 N. H. McKinzie, 208 E. Illinois St., Chicago, Ill......................Member
14 Francis Floyd Carter, 26 S. Spring Ave., LaGrange, Ill...............Student
15 Edwin L. Cheatle, 1744 W. 100th St., Chicago, Ill...................Associate
16 Stanley Frederick Bristol, 5323 W. Ohio St., Chicago, Ill.............Student
17 Julian C. Frank, 1002 Powers Bldg., Chicago, Ill...........Transfer—Junior
147 D. Royce Hyde, 5446 Dorchester Ave., Chicago, Ill....................Student
172 Arthur Joseph Warren, 1847 Addison St., Chicago, Ill................Junior
181 C. Gustav F. Corduan, 5413 Windsor Ave., Chicago, Ill...............Member

APPLICATIONS RECEIVED

Applications for membership were received by the Board of Direction since its meeting held February 21, 1921, as follows:

18 Frederick Wm. Grove........................West Lafayette, Ind. (Transfer)
19 Reuben E. Cain........................321 S. Marshfield Ave., Chicago, Ill.
20 Kurt Carl Barth.....................17 Battery Place, New York (Transfer)
21 Jerome A. Moss...........1230 Transportation Bldg., Chicago, Ill. (Transfer)
22 F. A. Trujillo............................106 E. Walter Place, Chicago, Ill.
23 Joseph L. Kobylanski.........................3040 Davlin Ct., Chicago, Ill.
24 Homer Ellery Anderson..........154 E. Superior St., Chicago, Ill. (Transfer)
25 R. L. Sandberg..................4951 N. Oakley Ave., Chicago, Ill. (Transfer)
26 Carmine Chas. Laurine..............909 S. State St., Chicago, Ill. (Transfer)
27 Lambert B. Penhallow.........6346 Grennwood Ave., Chicago, Ill. (Transfer)
28 Frank J. McLaughlin............6006 Berenice Ave., Chicago, Ill. (Transfer)
29 A. W. Holmes...................5619 Drexel Ave., Chicago, Ill. (Transfer)
30 Karl M. Whitehead...........3247 S. Michigan Ave., Chicago, Ill. (Transfer)
31 Thomas F. Shea...................McCall Bldg., Memphis, Tenn. (Transfer)

Members are requested to communicate with Secretary with regard to qualifications of the above applicants for membership in the Society.

EDGAR S. NETHERCUT, *Secretary.*

ENGINEERING EMPLOYMENT

We wish to assist in placing valuable men in the employment most suited to them. Many concerns have positions open now or will have in the near future. What could be more logical than an engineering employer obtaining assistance from an engineering society, or an engineer looking for a position to seek a source that is in close tough with the engineering profession? You can co-operate by communicating with the Secretary's Office.

POSITIONS WANTED

B-925: POSITION WANTED—AFTER JUNE 1, on refrigeration, power plant or heating and ventilating. Experience 5 years in above fields.

B-924: POSITION WANTED IN TEMPORARY drafting—mechanical, structural.

B-923: POSITION WANTED AT ELECTRICAL works of any character, including X-Ray apparatus.

B-922: POSITION WANTED AS SALES REPresentative or architectural drafting. Experience 4 years. Will consider part time work.

B-921: POSITION WANTED WHICH WILL lead to engineering organization or executive work by graduate C. E., University of Illinois. Experience covers drafting, detailing, layout and design. Also field experience, railway bridge and tunnel construction and state highway work.

B-920: POSITION WANTED AS SALES ENgineer, structural or mechanical engineer. Experience 13 years.

B-919: POSITION WANTED AS FOREMAN, checker, designer, layout man or drafting (detailing). Experience 17 years covering blast furnace, steel works and rolling mill design.

B-918: POSITION WANTED AS ARCHITECtural engineer, sales engineer or draftsman. Experience in timber, structural steel and reinforced concrete design; also railroad construction.

B-917: POSITION WANTED AS STRUCTURAL checker. Experience 15 years detailing, checking and designing struction steel.

B-915: POSITION WANTED IN MECHANICAL drafting. Experience 2 years.

B-914: POSITION WANTED AS SALES ENgineer, in structural products by graduate C. E. Armour, 1913. Experience 6 years in steel and concrete design and sales.

B-913: POSITION WANTED AS CHIEF draftsman, assistant engineer, estimator, checker or draftsman. Experience 11 years City Engineer, State Highway and construction work, including water works survey.

B-912: POSITION WANTED—OFFICE, FACtory or sales. Experience 4 years foreman and on construction. Last connection on installation of cost system.

B-911: POSITION WANTED WITH HYDRAUlic engineer by young man, good draftsman and concrete designer. Want opportunity to learn and obtain a general experience in hydraulic structures.

B-910: POSITION WANTED AS RESIDENT engineer, or instrument man on maintenance. Experience 30 years, as resident engineer, assistant engineer and instrument man and private practical civil engineering.

B-909: POSITION WANTED AS DRAFTSMAN. Experience 7 years mechanical and structural work, including dies, tools, packing house, chemical plant, building machinery.

B-908: POSITION WANTED AS STEEL OR concrete designer. Experience 4 years on industrial buildings.

B-907: POSITION WANTED—SALES ENGINEER or machine designer, mechanical or electrical. Experience 15 years.

B-906: POSITION WANTED—ON ENGINEERing investigation work. Experience 7 years, inspection, testing and general engineering investigation.

B-905: POSITION WANTED AS RESIDENT Engineer, inspector for engineering firm in field or estimator for contractor. Experience 5 years in above fields.

B-904: POSITION WANTED IN MACHINE design, piping work or conveying machinery. Broad experience.

B-903: POSITION WANTED AS DRAFTSMAN. Experience in design of office and industrial buildings.

B-902: POSITION WANTED—PART TIME OR permanent in technical writing, power plant testing or operation or sales engineering. Experience 5 years in steam and electrical fields.

B-901: POSITION WANTED ON ESTIMATING and pricing building construction, designing re-inforced concrete or superintending construction; at present employed. Experience 15 years familiar with office management and buying.

B-900: POSITION WANTED IN CONSTRUCtion work, preferably near St. Louis.

B-899: POSITION WANTED ON ARCHITECtural appraisals or steel and re-inforced concrete drafting. Experience 3 years in former and 2 years in latter work.

B-898: POSITION WANTED AS MECHANICAL draftsman on special or commercial machinery. Experience 4 years.

B-897: POSITION WANTED IN DEVELOPment work—chemical, electrical or mechanical. Experience in supervision, experimental and development work in chemical and dye factory.

ADDRESSES WANTED

In order to have our records of members' addresses complete, we ask that anyone knowing the present address of members listed below to communicate with the Secretary.

NAME.	LAST ADDRESS GIVEN.
James L. Anning	Rice Hotel, Houston, Texas.
Charles Bohasseck	Care of Jarvis Hunt, 1508 Michigan Ave., Chicago, Ill.
Geo. H. Brown	Carlinville, Ill.
Harold Cohn	168 W. North Ave., Chicago, Ill.
John F. Danley	645 N. Michigan Ave., Chicago, Ill.
H. W. Deakman	Lieutenant, 311th Engineers.
R. B. Easton	Aberdeen, South Dakota.
Floyd E. Evans	5252 Calumet Ave., Chicago, Ill.
Earl Hilton	5237 Ingleside Ave., Chicago, Ill.
W. A. Jaegemann	1355 Elmdale Ave., Chicago.
H. N. Jones	240 Taney St., Gary, Ind.
Walter W. Last	3015 Davlin Court, Chicago, Ill.
Arthur T. Maltby	20 W. Jackson Blvd., Chicago, Ill.
Miles H. Mann	Teetor Adding Machine Co., Des Moines, Ia.
Emmett R. Marx	6227 Ingleside Ave., Chicago, Ill.
T. R. Minert	1606 Hewitt Ave., Chicago, Ill.
A. G. Moulton	2095 W. Grand Ave., Detroit, Micha.
Vincent Pagliarulo	628 Grace St., Chicago, Ill.
Roger C. Palmer	U. S. S. M. A. Barracks I, Champaign, Ill.
John L. Parsons	1329 Ninth Ave., Fort Dodge, Iowa.
Louis A. Pettibone	Fon Du Lac, Wisconsin.
Jerre T. Richards	13323 Emily St., Chicago, Ill.
Henry Roth	1515 W. Monroe St., Chicago, Ill.
James Rowe	6626 University Ave., Chicago, Ill.
Herman H. Simpson	6733 Emerald Ave., Chicago, Ill.
C. W. Smith	185 Broadway, New York City, N. Y.
Gilman W. Smith	301 N. Menard Ave., Chicago, Ill.
Morton E. Smith	7516 Murphy St., Chicago, Ill.
Awred J. Sommer	211 St. Lawrence Ave., Beloit, Wis.
James Sorenson	511½ Cramer St., Milwaukee, Wis.
R. B. Stearns	245 State St., Boston, Mass.
John Stone	Aviation Corps, Ohio State University, Columbus, Ohio.
James H. Ticknor	4441 Magnolia Ave., Chicago, Ill.
Harry M. Trippe	Major Engrs. 308th Regt. Camp Sherman, Ohio.
Francis M. Wright	Dwight P. Robinson & Co., 61 Broadway, New York, N. Y.
Edward Wilmann	1462 Avenue G. Flatbresh, Brooklyn, N. Y.

SECRETARIES OF ENGINEERING SOCIETIES
CHICAGO, ILL.

Organization	Secretary	Address	Telephone
Am. Soc. C. E. (Illinois Section)	W. D. Gerber,	913 Chamber of Com.	Franklin 2243
A. S. M. E. (Chi. Section)	J. D. Cunningham,	2240 Diversey Blvd.	Armitage 254
A. I. E. E. (Chicago Section)	M. M. Fowler,	925 Monadnock Blk.	Har. 9800
A. I. M. E.	F. G. Fabian,	1025 Peoples' Gas Bldg.	Har. 470
Am. Ry. Engrg. Assn.	E. H. Fritch,	431 S. Dearborn St.	Har. 1069
Am. Chem. Soc.	S. L. Redman,	460 E. Ohio St.	Sup. 7920
Am. Soc. Htg. & Vent. Engrs.	Benj. Nelson,	1301 Monadnock Blk.	Wab. 9038
Am. Soc. Refrig. Engr.	Thos. McKee,	431 S. Dearborn St.	Har. 5643
Am. Steel Treaters Soc.	H. Blumberg,	Ill. Steel Co., S. Chgo.	S. Ch. 4000
Am. Inst. Architects	Ed H. Clark,	8 E. Huron St.	Sup. 1461
Assn. I. & S. Elec. Engrs.	W. H. Williams,	1501 Monadnock Blk.	Har. 1190
Am. Assn. of Engrs.	W. H. Dean,	29 S. LaSalle St.	Cent. 73
Am. Welding Soc.	L. B. Mackenzie,	608 S. Dearborn St.	Wab. 7134
Ill. Soc. of Architects	Ralph C. Harris,	192 N. State St.	Rand. 2409
Ill. Soc. of Engrs.	E. E. R. Tratman,	1570 Old Colony Bldg.	Har. 2196
Illuminating Eng. Soc.	Jas. J. Kirk,	72 W. Adams St.	Rand. 1280
Natl. Assn. Prac. Ref. Engrs. (Chgo. Sub.)	A. J. Plocinsky,	1505 S. St. Louis Ave.	Rand 6984
Soc. Automotive Engrs. (Mid-West Section)	L. S. Sheldrick,	910 S. Michigan Ave.	Har. 1455
Soc. Industrial Engrs.	Geo. C. Dent,	327 S. LaSalle St.	Wab. 3291
Struct. Engrs. Assn.	John P. Cowing,	30 N. LaSalle St.	Frank. 778
Swedish Eng. Soc. of Chicago	C. H. Mayer,	404 Monroe Bldg.	Rand. 6120
Western Society of Engineers	E. S. Nethercut,	1736 Monadnock Blk.	Har. 945

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CURRENT ENGINEERING ACTIVITIES

DUST EXPLOSIONS

Mr. David J. Price, Engineer in charge Grain Dust Explosion Investigations, of the United States Department of Agriculture, Bureau of Chemistry, gave a talk on grain dust explosions at this meeting, held March 28th, 1921. He has promised to come again soon and give us a more elaborate paper, but being in the city, and in view of the fact that we have recently had a very disastrous calamity at one of our grain elevators, and being a timely subject, we thought it would be of interest to the membership.

Mr. Price spoke as follows:

"I have agreed to talk about dust explosions tonight, with the very definite understanding with the Secretary that whatever I say will have no direct or indirect reference in any manner whatsoever to the explosion which occurred in the Northwestern Elevator a week ago last Saturday. Th investigations are being carried on by the City, State and Federal Government, and are not yet completed, and I don't want my remarks in any manner to be interpreted as referring to that particular explosion. I appreciate the opportunity, however, of coming before the Engineers of Chicago and talking on this subject, because my own conviction is that the prevention and control of dust explosions is going to rest almost entirely in the hands of the industrial engineers of this country. By that I mean, the application of the methods of prevention and control outlined and established by the engineers in the Bureau of Chemistry in the Department of Agriculture must be applied in a practical way by the engineers of all classes in this country before occurrences of dust explosion nature can be prevented.

"When we stop to consider that in the last few years we have had explosions of this kind in industries that have not been considered dangerous from a dust explosion point of view, you can probably appreciate what I have in mind. The Department of Agriculture has for several years been devoting considerable time to this subject and no doubt many men in the audience tonight have attended public meetings held the last

few years in which the question of dust explosions has been very fully discussed and considered. In fact, the surprising thing has been that some of these explosions are occurring in plants that have not been considered in any way dangerous as far as the dust explosion hazard is concerned.

"Quite recently the engineers of the department were called upon to investigate an explosion of rubber dust occurring in the recovery of hard rubber. That was a sort of a new form of explosion. It cost the lives of nine men and it indicated that certain by-products in certain industries are now being utilized, in which very fine dust is produced. My own feeling is that that may account for some of the explosions that have taken place in some of the industries that we have not regarded as dangerous.

"We might cite an example of that in the cereal industry, where in recent years the oat hull has been utilized and is now being ground for the manufacture of cattle feed. That being a by-product some years ago which was more or less waste, and as you come down through the industries we may explain the frequency of explosions by the utilization of by-products that were, not many years ago, considered as waste. In the grinding or in the manufacturing process very fine dust is, therefore, created and the explosion follows.

"The theory of dust explosions should not be a difficult one to understand, because upon analysis, it is very simple. It has been found in the tests that the finer the dust and the drier the dust, the more explosive its condition. This is quite natural, because the finer the dust, the nearer the molecules approach the size of gas molecules, and what occurs in a gas explosion is very similar in form to what occurs in the dust explosion, in fact, almost identical. The dust does not explode, of course, like dynamite. It is simply a rapid propagation of flame. Just what occurs when the explosion takes place is being somewhat debated at the present time. Some of the physical chemists claim that the dust upon being heated distills explosive gases, while others state that it is not the case, but that the explosion is so rapid it is nothing more than a rapid rate of flame travel creates a tremendous pressure and the explosion follows.

"In the industrial plant one explosion only, rarely takes place,—there are usually two and in some instances three. That has been explained in this way: the original dust explosion might be just the ignition of small quantities of dust and air, which produces sufficient concussion to jar or shake into the air any dust that might be lodged on girders, beams or ledges or any parts of the plant. This dust feeds and propagates the flame, from the primary explosion, resulting in the secondary or vital explosion, which is the one that usually causes the extensive damage.

"The Department of Agriculture has been called upon in recent years to look into many interesting cases of explosions, not only in industrial plants, but in the operation of farm machinery. One particular problem between the Cascades and the Rockies, in the Pacific Northwest, has shown that in some seasons as many as six hundred explosions

vicinity of Spokane, Wash., and the surrounding territory. Although at first the operations of the I. W. W. were assigned as the cause of the have occurred in five weeks' time in the threshing of wheat in the explosions, the investigations showed there were some scientific developments. Now I am not saying the I. W. W. wouldn't do these things if they got the chance, and probably in some instances did them. The scientific development, however, was this, the wheat in the territory was diseased with smut dust and that dust was very explosive, and the remarkable part of the investigation was that the machines operating in the field generated a large static electric voltage. The engineers have tried to measure that discharge and I understand in some cases it runs as high as fifty-two thousand volts, although if that is a fact it is, of course, at very low amperage. But at any rate it made a very hot spark, and the passing of the spark from the cylinder teeth to the concaves in the threshing machine ignited the dust. Of course, the thresher operator laughed at the idea at first that he was generating enough electricity with his machine to burn him up or blow him up, but nevertheless the scientific investigations disclosed that to be the fact, and the wiring of those machines has controlled the frequency of those explosions.

.. "A year or two following that investigation the Department was called upon to look into a frequent series of fires in the cotton gins in the South. This happened during the war, in 1917, and of course they were all "pro-German cases," in which matches were being introduced with the cotton, supposedly. But an investigation disclosed that the fires were very similar to the cases in the Pacific Northwest. The friction of the cotton on the galvanized pipe in passing from the wagon to the gin, built up the charge which ignited the cotton, and led to a grounding arrangement which materially reduced the fires resulting therefrom.

"And all the way down the line we find that the explosions are occurring in the representative lines of industry and in the operation of certain machines or equipment where these conditions exist or the dust is present. You all know back in 1878 the explosion that occurred in Minneapolis when the Washburn-Crosby Mills on the 2nd of May that year blew up. That led the introduction of improved types of dust collecting equipment, and I have been interested in just making a few notes this afternoon as to what Professors Peck and Peckham did on this subject almost fifty years ago in Minneapolis. They were called upon by the coroner to investigate the cause of this explosion and conducted certain experiments. In their work they reported they constructed a box containing about two cubic feet of air space and by blowing two ounces of flour dust on to a Bunsen burner on the inside of the box they were able to lift two men standing on the lid of the box. In other words, that two ounces of flour dust when ignited would raise the possible weight of three hundred pounds. A physical chemist with the chemical composition of flour known has taken that calculation and on that basis assumed that if it were possible to release—now I say if it were possible, because it might be difficult,—but if you could do it—if it were possible to release a sack of flour, and diffuse it at that ratio, on the basis of that experiment, that one sack of flour would lift twenty-five hundred tons one hundred feet high. Now, of course, that is decidedly theoret-

ical, because it would be hard to do that, but if it could be done, one sack of flour would generate sufficient pressure to raise a weight of that amount one hundred feet high.

"In another investigation the Bureau of Mines finds that .02 of an ounce of coal dust per cubic foot of air space,—about 1-50 of an ounce,—is sufficient to produce an explosive mixture. The explosive range of methane gas is from 5½ to 14 per cent. That simply means with methane having less than 5½ per cent you get no explosion; when you have over 14 per cent there is too much gas present, but the range is between those two extremes. With .02 of an ounce of coal dust per cubic foot of air space you would get a mixture that could produce an explosion. Now I take that as a standard because we have made coal dust the standard in the tests but find that the grain dusts are more explosive, so it would probably take less grain dust than it would coal dust.

"Now I know figures are usually monotonous and uninteresting but I have a few here that I want to take time to read to you to give you some idea of the tremendous pressures created when explosions of this kind occur. On the basis of .02 of an ounce per cubic foot you would only need in the average room 20x20x10 eighty ounces; or five pounds of dust diffused in proper proportions through the air in a room of that size would be sufficient to blow it apart. One hundred pounds of dust would blow twenty rooms 20x20x10, or over eighty thousand cubic feet, apart. Now I am just taking a ton of dust, two thousand pounds, for example, and that would be sufficient to blow apart four hundred rooms 20x20x10, or a total os 160,000 cubic feet.

"In the laboratory experiments, by using 75 milligrams of dust, just a small quantity, in a little vessel of 1,400 cubic centimeters capacity we have produced as high as 20 pounds pressure per square inch. I give these figures to show the terrific explosive force contained in dusts when mixed with the right proportions of air and subject to conditions that are favorable to explosion.

"Now I might summarize my little talk with just three conclusions. First there are certain engineering problems that must be solved before we can expect to control or prevent these dust explosions. The recent cases that have occurred in both this country and Canada have taken place in the most modern, well-constructed and well-equipped plants. It has been demonstrated that a so-called "fire-proof" plant, a plant built of fire resistive materials, by no means is explosion-proof. If it is well constructed, it must be well maintained. Construction engineers must recognize the hazard and danger of dust explosions and not permit any opportunity for the accumulation of dust in any manner whatsoever, because an accumulation of dust when forced into supervision, will naturally permit the propagation of the flame from the primary explosion.

"The second point is the progress recently made in determining that electrical sources are largely responsible in many cases for these disastrous explosions. A recent case in the Southwest indicated that the breaking of an incandescent lamp bulb by one of the workmen car-

rying something on his shoulder, ignited the dust and caused an explosion. That was a point that was not accepted by the electrical engineers at the time, on the basis that when you break the bulb you destroy the filament and thereby remove the possible source of ignition. The Bureau of Chemistry took up the matter with the manufacturers of electric lamps,—the National Lamp Works, the Westinghouse and the Edison Lamp Companies, and conducted a co-operative series of experiments at the Nela Park Laboratory of the National Lamp Works, Cleveland, Ohio. These tests established very definitely that there is not a type of electric lamp made but that when the bulb is broken will produce dust explosions immediately if there is the proper proportion of dust in the air. You can see what that means. That introduced a new element of danger. It means that the use of electric bulbs in dusty atmospheres is unsafe. They must have vapor-proof coverings; a mere wire guard is not sufficient. Upon introduction of a lamp into a bin or a dusty part of the plant, if the bulb is broken, the explosion follows immediately.

"It also developed in that investigation that the dust settling on the lamp globes may lead to resultant fires. With certain kinds of dust, the dust reaches the point of incandescence and fire follows. If the dust particles that have been set afire drop on to the floor fire ensues, or if they drop through the air in which the dust is suspended in proper proportion the explosion will follow.

"That simply means that we have got to recognize what we consider the advanced lighting methods in our industrial plants as affording a possible cause of dust explosions. We must take the necessary steps to control the static electric conditions that produce sparks in certain types of milling machines, and which will ignite dust, beyond question.

"The other important matter that I want to present is a subject for very grave discussion, in our judgment, but will have to be decided in this country and Canada very soon, before we can attempt to make progress on control of dust explosions. As has already been said, the flour milling industry has made progress in dust explosion prevention by collection of dust, by the introduction of improved types of dust collecting systems. It is rather difficult now to do that in a grain elevator, and I don't want to be misunderstood by what I am going to say, because the proposition that I am going to submit has not reached a definite state. I don't believe, personally, we are ever going to prevent explosions in grain elevators until we come in some way to a system for collecting the dust. By that I mean that the possibility of suction or aspiration on the grain from the time the grain enters the elevator until it leaves should be looked into—in other words, we might put it this way: an application of suction at every point where the grain is thrown or handled. That cannot be done in any large terminal elevator now because the possible difference of weights between the shipper and the receiver prevents that. But I venture to say if we were handling a material that had gasoline or dynamite or something else like that in it, we would take it out, probably very quickly. Science has established the fact that dust is explosive material, that dust explosions are occurring, on a large scale, today in both this country and Canada from

those causes, and yet the dust cannot be taken out until some adjustment is made between the parties in the controversy, the shipper and the receiver. I am not saying how it can be done, but I am going to concede the fact that we do take out a number of pounds of dust, and I am going to weigh the cost of that dust against the cost of dust explosions in both life and grain property, and I am going to submit to your better judgment as engineers that this must be solved, and that we will think over some way of solving it. When we can look at it in that light, that we are going to collect an explosive material, I believe we are going to make progress.

"Now I appreciate the other side of the question, that of the weightmasters, the Board of Trade and the Grain Exchange,—they must have the weights equalized, but the difficulty is we must depend upon the human element for dust removal on that basis, and I am looking forward to mechanical equipment to take it out effectively at every source where it is produced and handled. I will submit that to your better judgment tonight, as engineers, for your thought and consideration, whether it is not better to take out that dust and to a large extent reduce the explosions, and weigh that loss against the loss in life and property that results from one of these explosions.

"Now we are going to produce a little explosion here if we can get the starch to ignite. We have here a package of corn starch which was bought on the open market; it hasn't been doctored up, and I am just going to Have Mr. Brown place some of this in the cheese cloth and use a can of "Sterno" or canned heat to ignite the dust to show you the relative ease ignition and and the rate of flame propagation. About the time we stop shaking this cheese cloth would be about the time the explosion would begin. I am going to show just the first ignition or the primary stage. This is representative of the first ignition that we call the primary explosion. (Illustrating.) If there were sufficient dust in the room the concussion would shake it loose and the secondary explosion would follow.

"I thank you for your time and I hope that later we can show you the apparatus that we have and the methods of producing explosions and some of the motion pictures on the subject, and also discuss this subject with more freedom after our work here is completed."

COMMITTEE PROGRESS REPORTS

DEVELOPMENT COMMITTEE

E. T. HOWSON, Chairman

Following the preparation and distribution of the questionnaire to the membership recently, the Development Committee has awaited the return of the replies before attempting to prepare an analysis. Although a large number of replies have been received and the committee has received many valuable suggestions from them, many questionnaires are still outstanding in the hands of the members. The committee again urges that the members share with the Board the responsibility for the direction of the Society's activities by giving the Development Committee and through it the Board of Direction, the benefit of their individual opinions regarding the questions raised in the questionnaire which are the problems facing the Board of Direction. These replies should be sent in promptly as the committee expects to undertake their analysis within a short time.

PUBLIC AFFAIRS COMMITTEE

ANDREWS ALLEN, Chairman

At the meeting held April 18, at the Chicago Engineers' Club, the Public Affairs Committee considered the report of the sub-committee on the matter of "Qualifications of the recent appointee as Assistant Chief Engineer of the Sanitary District of Chicago." This report was unanimously adopted.

The Public Affairs Committee recommends that a protest on the appointment of Mr. Moore be sent to the Board of Trustees of the Sanitary District of Chicago; that the office of Assistant Chief Engineer should be filled by a professional engineer, selected on the basis of his qualifications and experience and that he should be a man capable of acting as technical advisor to the Chief Engineer and able to assume his duties if necessary. The Committe further recommends that publicity be given to this recommendation.

This report has been made with no reference to the personality of the appointee and with regard solely to the qualifications of the office, and it is our opinion that this opportunity should not be lost sight of for emphasizing the confusion which has resulted in the public mind from the use of the word "Engineer," both to designate the professional engineer and stationary and operating engineers whose duties are non-professional.

The Public Affairs Committee presented a resolution to the Board of Direction endorsing Senate Bill No. 81, which amends the present Zoning Enabling Act in accordance with the recommendation of the Zoning Conference held in Chicago in 1919:

"Whereas, The state law governing the zoning of cities is undesirable in three important particulars, namely:

"1. It contemplates the partial zoning of cities instead of comprehensive zoning;

"2. It allows fifty per cent of property owners in any area to be excluded from the operations of a zone plan, and

"3. It prescribes cumbersome and impracticable methods of notification to property owners, and

"Whereas, Senate Bill No. 81, introduced on February 16, 1921, was prepared by a group of distinguished lawyers, friends of zoning, with the advice of Edward M. Bassett, of New York, and will, if passed as drawn, afford an example of unexcelled value for legislation of this type; therefore

"Be It Resolved, That the Public Affairs Committee of the Western Society of Engineers, having given consideration to Senate Bill No. 81, recommends and urges that the legislature enact this bill into law."

This resolution was approved by the Board of Direction.

PUBLICATION COMMITTEE

P. D. VAN VLIET, Chairman

Any report of activities of the Publication Committee is best looked for in the publications of the Society. The Committee seeks to make the Current News Section of the Journal interesting and must look to the membership for much of its contents. Personal notes, particularly, are available only as items are forwarded to the Secretary.

Don't forget, when you hear of anything interesting to fellow members, that the Journal can carry it only as you send word to the Secretary.

You may have noticed that the Journal is now published at Fort Wayne, Ind. It was in the interest of economy and should it become cheaper to publish in Chicago we will again move. The publication of the Journal is one of the large items of expense to the Society and in spite of increased cost the budget has been adhered to.

WATERWAYS COMMITTEE

EDMUND T. PERKINS, Chairman

The Terminals Committee recommended the adoption of the following resolution with regard to the proposed harbor improvement outlined by United States Engineer, Col. W. V. Judson, to be located at Wolf Lake and to be known as the Illiana Harbor Project:

"Whereas, The future port of Chicago must reasonably include as a major element large transshipment facilities to enable it to fulfill its function as the principal rail-water gateway;

"Therefore be it Resolved, That the general project known as the Illiana Harbor Project be accorded the actual support of the Committee on Terminals and of the Committee on Waterways of the Western Society of Engineers to the end that legislative action may be put under way to preempt the areas required in behalf of and for the future benefit of the public as may be determined by a joint legislative committee or conference;

"And be is further Resolved, That this resolution indicating the tentative approval of these committees be transmitted to the United States Engineer and the Governors of the States of Illinois and Indiana and the Mayors of the principal cities within this district, Association of Commerce, Commercial Club, Union League Club, City Club, Sanitary District, and the press."

This resolution was approved by the Board of Direction.

PERSONAL NOTES

James Rowland Bibbins, M. W. S. E., has resigned as Supervising Engineer of The Arnold Company, to become Manager of the Department of Commerce and Communication of the United States Chamber of Commerce at Washington, D. C. He was educated at Baltimore City College and the University of Michigan. Later he became engaged in the electric and railway utilities work at Detroit, Mich. He then entered the service of the Westinghouse Company, being engaged in economic research in the development of steam and gas power. Mr. Bibbins became associated with The Arnold Company at Chicago in 1909 and since then has undertaken many important engineering investigations and reports for public bodies and various corporations. In his new work with the Department of Transportation and Communication he will be in close touch with ocean and inland waterway shipping; steam and electric railroad transportation, cables and telegraphs, postal facilities, and highways. Mr. Bibbins was Chairman of the Terminal Committee of the Western Society of Engineers and Chairman of the Chicago Section of the American Institute of Electrical Engineers.

T. E. Barker, M. W. S. E., and Vice-President of the American Society for Steel Treating, is leaving Chicago on June 1st for Denver, to accept the position of Superintendent of the Denver Rock Drill Manufacturing Company.

Mr. Barker was a guest of honor of the Chicago Chapter, American Society for Steel Treating, at their meeting held April 12, 1921, at the City Club, and on this occasion he was presented with a very beautiful percolator and coffee set as a token of the high esteem in which he is held by the members of the Chicago Chapter.

Mr. Barker has been Production Engineer of the Miehle Printing Press and Manufacturing Company for the past nine years.

The very best wishes of the Western Society of Engineers go with Mr. Barker in his new position.

Thure W. Ingemanson, J. W. S. E., has been appointed resident engineer on paving work at Nora Springs, Iowa.

FROM THE SECRETARY'S OFFICE

Edgar S. Nethercut, Secretary

Amendment to Constitution

At the meeting of the Society held April 4th, the amendments to the Constitution were discussed and a slight change was made in the wording of the amendment to Article XV in order to clarify the method of determining the necessary two-thirds vote in order to adopt the amendment. At this meeting considerable discussion was had with regard to the merits of the increase in dues. This, of course, is a debatable question. The Board of Direction has, however, had this matter under consideration for a year or more and it is felt, that the Society should function in a large way and that inasmuch as the expenditures are entirely for the benefit of the Society and its members and in the furtherance of their civic duties, there should be sufficient funds on hand to enable it to do these things in a large way. This will go down to the credit of the Society and its members. The withholding of financial support would be unfortunate and tend to retard the advancement of the profession.

Accompanying the ballots to the members was the following circular:

April 14, 1921.

To the Corporate Members,
Western Society of Engineers:

It was the sense of the meeting held April 4th, at which time the amendments to the Constitution were being discussed, that there should accompany the ballot a statement bearing on these amendments. Herewith find statements prepared by Mr. A. S. Baldwin, Chairman of the Amendments Committee, and by Mr. F. F. Fowle, Treasurer and Chairman of the Finance Committee.

I am directed by the Board of Direction to enclose these statements with the ballots herewith.

Edgar S. Nethercut,
Secretary.

The Constitution of the Western Society of Engineers does not give the Board of Direction sufficient latitude in handling matters that are not of fundamental importance. It is proposed to make a revision of it, and in doing so to make a division between "Constitution" and "By-Laws," putting in the By-Laws the less important matters of management that should be handled by the Directors.

Practically all of the large national societies have such an arrangement, or are revising their constitutions to bring it about.

A new Constitution and By-Laws were tentatively prepared by the Committee on Amendments, but it was found to be impracticable to get it before the Society in proper shape before the first regular meting in March as required by the present Constitution. It was determined to present two amendments only to be considered at the first regular meeting in April, one to the effect that amendments may be filed with the Secretary at any time, thereby avoiding the necessity for postponing action on the revised Constitution and By-Laws for a whole year, and another providing for the increase in dues of members of the Society.

The present dues and the proposed dues are shown by the following statement:

	Present	Proposed
Resident Members	$15.00	$20.00
Resident Associate Members	12.50	16.50
Non-Resident Members	10.00	15.00
Non-Resident Associate Members	8.50	12.50

Such an arrangement would increase the amount of income from approximately $33,510.00 to $45,388.00, an increase of $11,878.00.

The Board of Direction regrets exceedingly to make a recommendation of this kind. Such an increase, however, is not more than has been made in almost every department of life; every effort has been made by the Board to avoid it. and for several years the Society has not been in receipt of sufficient income to perform its activities in a thoroughly efficient and acceptable manner. It is hoped that the membership will take this increase in good part, realizing that the Society can not be of use to its members unless it is provided with sufficient funds, and that as engineers it is our duty to get behind the affairs of the Society, even at some personal sacrifice, with the determination of making it the instrument of good for the profession that it is capable of being.

If the amendment carries, the proposed new Constitution and By-Laws

will be submitted at the earliest practicable date. The Board believes that a return to normal conditions will warrant a reduction of dues at a later time.

A. Stuart Baldwin,
Chairman Amendments Committee.

The service now rendered by the Western Society of Engineers to the membership consists of four major activities, namely, (1) the holding of some sixty technical meetings per year, (2) the publication of the monthly Journal, (3) the maintenance of an engineering library including the services of a very competent librarian and assistant, and, (4) the free employment service. The value of this service is unquestionably recognized by the membership, as evidenced by the enthusiastic attendance at meetings, the constantly increasing use of the library and the patrcnage of the employment service.

Without doubt the Society renders greater service to its local members than they receive as a whole from any other professional society, local or national. Furthermore, the Western Society is recognized as the leading local engineering society of Chicago and its important surrounding territory, and it has been the policy of the Directors to maintain and improve the position of the Society in this regard in every practicable way. In order to promote this object, the Society affiliates with the National Engineering societies and also endeavors to speak with authority on all important local public issues in which any question of an engineering character is presented, or which affects the welfare of engineers as a whole. At the present time these activities of the Society are being directed by some two hundred members serving on the Board and the numerous committees, as a voluntary contribution to the welfare of all engineers in this territory and the membership in particular. The Society has never been in as strong position as regards membership and local public influence as it is today, and it is the hope of the present management that the members will support and continue the present policy.

In order that this may be accomplished however, it is necessary fo rthe Society to have a moderate increase in its income per member, which has not been increased since 1911, despite the marked increase in the cost of everything since that period. The budget adopted for the fiscal year 1920-1921, after considering every practicable economy without sacrificing the present major activities, was as follows:

1920-1921 Budget

Rent	$ 3,400.00
Payroll	17,500.00
Printing	8,800.00
Stationery and Postage	3,500.00
Miscellaneous	6,000.00
Total	$39,200.00

The distribution of this expense among the several activities is shown in the following summary:

Distribution

General Expense	$19,900.00
Technical Meetings	1,200.00
W. S. E. Publications	12,100.00
Library	4,500.00
Other Activities	1,500.00
Total	$39,200.00

At the outset it was recognized that the income for the period would fall short of covering the expense by about $4,000 to $5,000, and every effort has been made meanwhile to make up the amount without increasing the dues. These efforts, however, have not been successful, and therefort it is now proposed to increase the dues as shown in the accompanying amendment "A" to the Constitution.

If this amendment is approved by the membership, it will insure the continuance of the present important activities of the Society without curtailment and will avoid the unfortunate alternative of lessening the Society's local standing and influence, as well as the service which the membership now receives. Taken in conujnction with amendment "B," which facilitates further amendment of the Constitution whenever occasion arises, without waiting for the annual meeting, it will not only insure the future success of the Society but will also make it feasible to again revise the dues, preferably downward, whenever a general reduction in the level of costs or a substantial increase in our membership makes it practicable. It is earnestly hoped that this matter will receive full support.

F. F. Fowle, *Treasurer,*
Chairman Finance Committee.

To the Corporate Members,
Western Society of Engineers:

Pursuant to the provisions of the Constitution, the amendments ot the Constitution as presented at the meeting held March 7th were discussed and amended at the meeting held April 4th.

The amendments are submitted herewith for letter ballot. The Constitution provides that returns from letter ballot will be canvassed at the first meeting in May.

Please mark your ballot, *enclose* in *ballot* envelope and seal, placing same in addressed return envelope, sign your name in the upper left hand corner and mail so as to reach this office on or before May 2, 1921.

The amendments proposed are:

AMENDMENT "A"

Amend Article V, Section 1, to read as follows:

"Sec. 1. The entrance fee and annual dues for the various grades of membership in the Society shall be as follows:

	Entrance Fee	Annual Dues Res.	Annual Dues Non-Res.
Member	$15.00	$20.00	$15.00
Associate Member	12.50	16.50	12.50
Affiliated Member	12.50	20.00	15.00
Junior Member	5.00	10.00	6.50
Student Member	1.00	2.50	2.50
Honorary Member	None.	None.	None.

"From each of the annual dues $2.00 shall be set aside as subscription to the Journal.

"On transfer of a member to a higher grade, the entrance fee previously paid by him shall be credited against his entrance fee to his new grade."

AMENDMENT "B"

Amend Article XV to read as follows:

"Sec. 1. Proposed amendments to the Constitution shall be submitted in writing. and must be signed by not less than twenty-five Corporate Members and filed with the Secretary.

"Sec. 2. Amendments shall then be presented at the next regular monthly meeting of the Society. After such monthly meeting the proposed amendments shall be printed and mailed to all members of the Society at least fifteen (15) days prior to the next monthly meeting, at which meeting the amendments shall be in the order of business for discussion and may be modified in any manner pertinent to the original members present at such meeting.

"The amendments as thus revised shall amendments by a majority vote of the then be voted upon by letter ballot, which ballot shall be due and counted within thirty days after such meeting.

"In balloting on an amendment to the Constitution, an affirmative vote of two-thirds of all the ballots cast shall be necessary for the adoption of any proposed amendment. Amendments so adopted shall take effect at the next annual meeting, unless the amendment is accompanied by a resolution providing that it shall take effect at an earlier date."

SURVEYS

A recent story in the Saturday Evening Post contained the following paragraph:

"So Mary—as I may as well call her—talks to me a good deal about her trouble. At the State University she got smattered some with economics. In her junior year, she and three of her classmates made what they call a survey of X. That is a scientific term used by economists nowadays. It means tabulating the misery in a town and leaving out the rest."

This story was conversational between Mary and her friend, a banker. The banker was also a friend of Mary's father, who had prospered in the town called X. Because of regular employment in the town's only enterprise, a manufacturing establishment, in which he had placed his earnings and which was ably managed by a former superintendent, he had been able to give his daughter a college education.

As Engineers would we favor a partial survey?

One of our active members, under date of April 6th, wrote to the Secretary as follows:

"I was chatting this morning with Mr. T., who should have a pretty good general knowledge of engineering necessities and he painted the greatest, perhaps, as that of some organization taking the leadership with respect to road types and road costs,—not an organization controlled by motor men or material men but one of engineers broad enough and able enough to do something basic.

"I presented several arguments why the Western Society of Engineers should not be the one to delve in standards of type and cost, for the purpose of bringing out his arguments and he successfully convinced me that the Western Society of Engineers could do a very beneficial work, particularly to the State of Illinois, which lacks any such body of engineering counsel and which, under a change of administration, has apparently favored a revisal of standards set in the past."

The suggestions in this letter are worthy of consideration by the members of the Society. There are great possibilities in a matter of this kind.

The Old Time Railroad Civil Engineer

Some sunshine and lots of rain,
A few losses, a little gain,
Some happy days and lots of strife,
Is a railroad engineer's life.

Lots of work and a little play,
Some kind act done each passing day,
A few good-byes, a setting sun,
And a railroad engineer's life is done.

EDITORIAL

A Civic Service

Mr. Hoover, in an address before Chicago Engineers last December, said that congressmen had commented to him on the value of the testimony given before committees by engineers and that it was now recognized by some at least that an engineer's experience in gathering basic facts impartially and not as a special pleader, could assist proper legislation and do a commendable public service.

The question is, how can the engineer secure recognition in order to undertake this public service? As an individual his personal engagements will be along the lines of his special ability. It does occur that the interests that he represents will have rights which will be contended by other interests and it occurs frequently that private interests will be contended by public interests. A just plan before contending interests should result in desirable legislation.

In our country and under our Constitution private rights are guaranteed. They may, however, be contended or they may be abridged. The wise and capable engineer has a duty to protect private interests when they are just. Contending interests have rights and the engineer in his private practice can well represent them. There is, however, a larger service which does not jeopardize private interests,—it is the public good.

Individuality, the offer of service by an engineer, is fraught with dangers. The question of fairness will sometimes be raised. Engineers are loath to offer services individually for fear of having their integrity and motives questioned by contending interests. Collectively, however, through the Society representing his profession in a community, the engineer can do great service and do so without fear of having his motives assailed. Pending before the legislature at the present time are many bills greatly affecting public good. Facts, figures, methods of construction, specifications, plans, research and investigations such as an engineer is well prepared to undertake should be the basis on which these projects should stand or fall, rather than upon the political advantage to be gained by contending parties or factions of parties. Legislation having an engineering basis and which can be justified in the opinion of a group of engineers such as we have in the Western Society of Engineers should pass and if it is not justified by such a group it should fail. Legislatures are entitled to know what our opinion is on these things and this implies that we as a group should be better informed and have opinions.

Our Public Affairs Committee is organized for this purpose. We also have Applied Technical Committees organized to make studies of the large and complicated subjects affecting the welfare of the citizens as a whole. In order to be effective, however, the Society should have at its call men of wisdom to advise the Society in order that it may advise the public.

While the legislature meets only once in two years, the local municipal bodies are in constant session and considering matters of taxation, construction, health, safety and convenience, regarding which the engineer is well qualified to speak. Shall we prepare oureslves for this civic service?

ENGINEERING EDUCATION

Prof. M. E. Cooley, Dean of the College of Engineering, University of Michigan, at the Noon-Day Luncheon held on April 8th, said, in his opinion the Western Society of Engineers could do a constructive work by giving consideration to the essentials of engineering education.

Prof. Cooley, from his forty years of experience teaching engineering, had a very interesting message and in a very clear and logical manner analyzed the present situation before the engineering schools of the country. The large increase in attendance at all engineering schools and the inadequate appropriations for buildings, equipment and teaching force has thrown a burden on the educators which is very serious at the present time. This critical condition, however, suggests a careful study of the causes. Certain recommendations have been made toward relieving the universities and at the same time greatly increasing the educational benefits which come from the University course. Dean Cooley suggests the development of Junior Colleges in connection with High Schools, or the development of the smaller colleges well scattered throughout the states of the Middle West into Junior Colleges, teaching the first and second year work of the present University course. The upper class work could then well be carried on at the universities and an opportunity for post-graduate work developed to a larger extent.

A large increase in the number of students has presented a new difficulty in that sixty per cent of the freshman classes fail in one or more studies. This same percentage applies not only to the engineering courses but to the other courses of the colleges. Present education is inferior to that of thirty or forty years ago, said Dean Cooley. In specific lines for special training it is now superior but as education its inferiority is easily understood. Formerly when Civil Engineering was the only engineering course taught, only a half dozen textbooks were available and time was given in the engineering course for literature, history, science and English. There is little time now in the four years' course for these studies because of the highly specialized studies which have been introduced. The instance of sixty business men who in conference recently stated that they wanted the universities to turn out men who were trained for life rather than specific employment, is symbolic of the new attitude toward education.

"At the end of your day's work. when you return to your homes, what broad matters of interest outside of your profession have you for your families? Has your education given you an insight into life so you can be a companion to your wife and children?" This was a striking challenge that Dean Cooley gave to his professional brethren. He said the sag came when after fifteen or twenty years out of college you let down and lose your ardor for work, unless some interest becomes your pastime. A broad education will then be your safeguard.

The attendance at the Noon-Day Luncheon was not as large as it has been on former occasions but the importance of the message given by Dean Cooley was realized by all present. Mr. Murray Blanchard, M. W. S. E., as President, Michigan Engineers' Club, introduced Dean Cooley, giving a very fitting resume of the active life of service which he has given. Dean Cooley has been honored as President of the American Society of Mechanical Engineers and a Director of the American Society of Civil Engineers. He graduated from the U. S. Naval Academy at Annapolis in 1878 and saw active service during the Spanish-American war, being associated with the present Secretary of the Navy.

The Western Society of Engineers gained some publicity in the Chicago papers due to the presence of the Secretary at a meeting of the Finance Committee of the City Council recently, at which time a physical encounter took place. The remarks which were quoted in the papers were not accurate but possibly the comment could have been made in perfectly good grace. The Secretary was reported as saying, "This is no place for me. I will be back next week when it is calmer."

The discussion before the Finance Committee was a consideration of the proper fees to be charged by experts in estimating damages to land and buildings in connection with public improvements. Representatives of the Real Estate Boards, the Architect Societies and the Engineers testified that it was customary to make charges on a per diem basis, although it was permissible to enter into an engagement at an up set price when these engagements could be specifically covered by a proposition. Emphasis was placed upon the ability and experience of the expert who undertakes this work and recognition should be given to the fact that the amount of the fee should be based upon his experience and ability. It was evidenced that there was so much dissimilarity between engagements of this kind that it was difficult to arrive at any fair percentage which should govern.

The work of the expert should include a survey of the property and estimate of the reproduction cost of the buildings. Where the buildings are not entirely destroyed another estimate must be made, including some planning, to determine the method of severing the building and from this, determination of the value of the remaining portion. In addition to this an estimate must be made of the benefits coming to the property due to the improvements and an additional estimate must be prepared as to the benefits which come to the adjoining property in order to determine the spread of the special assessment. It is not clear that the last two items should be included in the work of the expert inasmuch as commissioners are appointed to make this determination.

The Western Society of Engineers, through its Public Affairs Committee, is glad of the opportunity to assist the local government in matters of this kind.

The Western Society of Engineers acknowledges with thanks receipt of two framed photographs from the Baldwin Locomotive Works.

These show A. T. & S. Fe—4-6-2 type and C. B. & Q., 2-10-2 type locomotives.

SPRING MEETING AMERICAN SOCIETY MECHANICAL ENGINEERS

The 1921 Spring meeting of the American Society of Mechanical Engineers will be held in Chicago, May 23rd to May 26th, at the Congress Hotel. There will be a reception Monday evening and morning sessions will be held on Tuesday, Wednesday and Thursday. The afternoons will be given up to excursions to points of interest throughout the city. The evening sessions will be social in character. Following the main meeting at Chicago an excursion will be made to the Rock Island Arsenal. Friday morning will be devoted to a trip through the arsenal with a technical meeting in the afternoon. Saturday morning will be given over to a golf tournament on the arsenal courts. On Saturday, May 21st, a preliminary meeting of the Aeronautic Section will be held on the McCook Field, Dayton, Ohio, jointly with the Society of Automotive Engineers.

Well developed programs will be presented by the Professional Divisions of the Society devoted to Forest Products, Fuels, Machine Shop, Management, Material Handling, Power, Railroad, and a specially important session will be devoted to Training for Industries.

The members of the Western Society of Engineers have been invited to join in all the meetings and furthermore, we have been asked to prepare for the Wednesday morning session, May 25th. This program has been arranged by the Engineers Terminal Committee of the Western Society of Engineers. The program as prepared by the Terminals Committee is not in the form of a report but consists of constructive papers by members of the Committee which bear upon the general subject.

In accordance with the policy of the Society these papers are not endorsed by the Committee or the Society but are submitted as contributions. The general plan of the meeting for May 25th is indicated by the following statement which has been prepared by the Committee:

JOINT SESSION AMERICAN SOCIETY OF MECHANICAL ENGINEERS, WESTERN SOCIETY OF ENGINEERS

May 25th, 1921—Morning Session

Arranged by Engineers' Terminal Committee of the Western Society of Engineers.

TRANSPORTATION.

Introduction.

On the occasion of the first convention of the American Society of Mechanical Engineers to be held in Chicago for sixteen years, the Western Society of Engineers, in line with its policy of co-operation with national bodies, has considered it a pleasant duty to co-operate in this May convention upon a subject of commanding interest, locally as well as nationally. The problem of transportation is chosen for this contribution in order that not only Chicago engineers but particularly visiting engineers from all parts of the country may reach some further insight into the magnitude and complications of the greatest railroad center on earth. The committee has selected certain major and minor subjects for discussion which it deems of importance and interest to the Convention.

SUBJECTS.

A.—Some Aspects of the Problem of Chicago as a Mid-Interior Rail-Water Gateway.

B.—Factors in Terminal Capacity and Development.

(1) Development of Air Rights in Connection with City Freight Houses.

(2) Mechanical Plan for Modern Types of Local Freight Houses for Large Centers.

(3) Freight Movement by Motor Trucks—Viewpoint of Carrier and Public.

(4) Freight Tunnel System as a Terminal Distribution Agency.

(5) Terminal Unification.

(6) The Function of the Terminal Survey.

C.—Relation of Steam Roads to Rapid Transit Development.

The subject of water transportation, notwithstanding its present importance, is not included in the Committee's discussion, for the reason that it is now under investigation by an international body, the report of which is expected shortly. At the 1920 Convention of the American Association of Port Authorities, this Committee was instrumental in presenting the various aspects of marine development, and particularly port-terminals, and for convenience reference is here made to the above report of the Terminal Committee on this convention, Western Society Engineers' Journal, November, 1920, also papers presented as follows:

BIBBINS, J. R.—Economic Lines of Gravitation for Overseas Movement from the Mississippi Basin. W. S. E. Journal, December, 1920.

MILLIS, JOHN—Nature's Preparations for Deep Water Harbors on the Great Lakes. A. A. P. A., Monthly Bulletin, October 1, 1920.

BRENT, THEODORE—Water Terminals for Chicago A. A. P. A., Monthly Bulletin, Ocotber 1, 1920.

CORNELIUS, J. F.—Why Deep Waterways and a New Chicago Harbor Will Greatly Benefit Chicago Real Estate. A. A. P. A., Monthly Bulletin, October 1, 1920.

WOODHULL, ROSS A.—Chicago's Problem as a Port, Past, Present and Prospective.

GLENN, JOHN H.—Chicago Harbor and Illinois Industry, A. A. P. A. Monthly Bulletin, October 1, 1920.

Other recent contributions on the general subject of Transportation are as follows:

BARNES, M. G.—The Illinois Waterway. W. S. E. Journal, May, 1921.

PEABODY, JAMES A.—Application of Engineering to Transportation Problems. W. S. E. Journal, November, 1920.

The members of the Committee who have contributed these articles include J. R. Bibbins, E. J. Noonan, J. D'Eposito, Harwood Frost, E. H. Lee, Hugh Young, J. H. Brinkerhoff, and Col. Bion J. Arnold. The morning sessions will convene at 10 o'clock. Special effort should be made by the members of the Society to attend all these sessions, especially that in which the Western Society participates.

Abstracts of papers to be presented May 25th are printed on pages 192 to 209 of the technical section of this Journal.

INSPECTION TRIPS AT A. S. M. E. SPRING MEETING, CHICAGO.

Industrial Chicago has many things to show the Mechanical Engineer, and is going to throw them open to inspection by those attending the Spring Meeting of the American Society of Engineers, May 23 to 26. The places which offer to entertain guests in this way are too numerous to be seen by all within the four days of the meeting, so several are scheduled for each day, so arranged, as far as possible, that the individual may suit his taste by selection daily without feeling that he is missing something he would like to see.

May 24

Tuesday—International Harvester Co., McCormick and Deering plants; Sears, Roebuck & Co., wall paper manufacture, handling and shipping merchandise; Mandel Brothers, package handling, coal and ash handling, connection to sub-street tunnel system; Western Electric Co., manufacture of telephone apparatus and cable for the Bell Telephone system.

May 25

Wednesday—Illinois Steel Co., South Works, South Chicago, plate mill, rail mill, Bessemer converters and general steel mill equipment; Commonwealth Edison Co., modern turbine central station at Fisk street; Pennsylvania Lines Terminal, freight handling plant, in connection with which there may be visited the neighboring warehouse of Marshall Field & Co. and the U. S. Terminal building; Crane Company, manufacture of valves and fittings in cast iron, malleable iron, steel and brass, the fabrication of pipe work.

May 26

Thursday—Chicago Mill and Lumber Co., 120-in. paper machine, manufacture of fibre, corrugated board and paper boxes; Clemetsen Company, manufacture of veneers and "Clemco" office desks; Pullman Company, Pullman cars, passenger coaches and freight cars; Underwriters' Laboratories, testing of appliances and devices for fire prevention; Yellow Cab Manufacturing Co., where the ubiquitous cabs come from.

May 27

Friday—Milwaukee Railway and Light Co.'s Lakeside plant, trip by rail to Milwaukee, boilers fired with powdered coal; Jos. T. Ryerson & Sons Co., warehouse of about a million square feet devoted to machinery and steel products.

MEMBERSHIP MATTERS

NEW MEMBERS

At the meeting of the Board of Direction, held April 18th, 1921, the following new members were elected:

19	Reuben E. Cain, 321 S. Marshfield Ave., Chicago	Junior
20	Kurt Carl Barth, 17 Battery Pl., New York	Associate
21	Jerome A. Moss, 1230 Transportation Bldg., Chicago	Member
22	F. A. Turjillo, 106 E. Walton Pl., Chicago	Associate
23	Joseph L. Kobylanski, 3040 Davlin Ct., Chicago	Associate
24	Homer Ellery Anderson, 154 E. Superior St., Chicago	Junior
25	R. L. Sandberg, 4951 N. Oakley Ave., Chicago	Member
27	Lambert B. Penhallow, 6346 Greenwood Ave., Chicago	Junior
28	Frank J. McLaughlin, 6006 Berenice Ave., Chicago	Member
29	A. W. Holmes, 5619 Drexel Ave., Chicago	Associate
30	Karl M. Whitehead, 3247 S. Michigan Ave., Chicago	Student
31	Thomas F. Shea, McCall Bldg., Memphis, Tenn.	Associate
269	James H. Ticknor, 4441 Magnolia Ave., Chicago	Junior
766	John A. Corboy, 178 W. Randolph St., Chicago	Member
1299	W. C. Adams, 21 E. Van Buren St., Chicago	Member

APPLICATIONS RECEIVED

Applications for membership were received by the Board of Direction since its meeting held April 18th, 1921, as follows:

32	Andrew J. Clouston	3518 W. Polk St., Chicago, Ill.
33	William L. Weaver	410 W. 41st Pl., Los Angeles, Cal.
34	Karl Udet (Transfer)	4913 Winthrop Ave., Chicago, Ill.
35	Leo Krumdieck	3654 S. Robey Ct., Chicago, Ill.
36	H. M. Goodman (Transfer)	P. O. Box 228, Honolulu, Hawaii
37	Jefferson Davis Harris	Shreveport, La.
38	Alva Harold Perkins	Camp Grant, Ill.
39	James M. Montgomery	3743 Costello Ave., Chicago, Ill.
40	George A. LaRue	Room 408, City Hall, Chicago, Ill.
41	Henry Frederick Hebley	741 Belden Ave., Chicago, Ill.
42	Herman W. Mueller	East Chicago, Ind.
43	Peter M. Larsen (Transfer)	Chanute, Kansas

Members are requested to communicate with Secretary with regard to qualifications of the above applicants for membership in the Society.

EDGAR S. NETHERCUT, Secretary.

ENGINEERING EMPLOYMENT

We wish to assist in placing valuable men in the employment most suited to them. Many concerns have positions open now or will have in the near future. What could be more logical than an engineering employer obtaining assistance from an engineering society, or an engineer looking for a position to seek a source that is in close tough with the engineering profession? You can co-operate by communicating with the Secretary's Office.

POSITIONS WANTED

B-950: POSITION WANTED IN RAILROAD, Industrial or Highway Work. Experience, 17 years drafting, estimating, field and supervision, including resident and division engineer. What have you to offer?

B-949: POSITION WANTED BY GRADUATE C. E. having 20 years' experience office and outside work in roadway, construction, bridges, buildings, land valuations and contracts.

B-948: POSITION WANTED AS DESIGNER or production superintendent. Experience, 12 years in mechanical an d electrical fields. Would like to make connection where there is field for improvement of products or methods and developing new machines.

B-947: POSITION WANTED IN DRAFTING or tracing by young woman with three years' experience.

B-946: POSITION WANTED AS DRAFTSMAN on mechanical drawings and details—Civil, Electrical, Mechanical and Construction work. Also design and detail sof electrical apparatus

B-945: POSITION WANTED AS ARCHITECTURAL draftsman or superintendent on building work. Experience, 18 years.

B-944: POSITION WANTED AS SALES ENGINEER, advertising or estimates on mechanical equipment or building products. Experience, 7 years.

B-943: EXTRA WORK SATURDAY AFTERNOONS and evenings, preferably to take home. Drawing and drafting, computing, designing, surveys. Map drafting, track layouts, structural detailing, checking. Experience, 10 years.

B-942: POSITION WANTED AS DESIGNER of steel structures, checker or squad foreman. Experience, 16 years. Prefer work in Chicago.

B-941: POSITION WANTED AS CONSTRUCTION inspector in Chicago.

B-940: POSITION WANTED AS CONSULTING or supervising engineer with Chicago concern. Prefer office work.

B-939: POSITION WANTED AS ENGINEER or superintendent on construction, maintenance, operation, or track elevation preferred. Experience, 6 years.

B-938: POSITION WANTED AS MECHANICAL draftsman on piping. Experience, 10 years as draftsman, designer, detailer and checker.

B-937: POSITION WANTED IN MECHANICAL of electrical engineering, plant evaluation or efficiency work. Nine years' experience.

B-936: POSITION WANTED—YOUNG MAN 21 years old. Experience, three years on heating and power plant equipment. Wishes work outdoors along mechanical lines.

B-935: POSITION WANTED AS STRUCTURAL designer. Familiar with concrete design. Experience in office and mill buildings, smelter structures, and theaters.

B-934: POSITION WANTED BY GRADUATE C. E. as superintendent of construction or on special investigations, making estimates and plans in connection with water and coaling stations.

B-933: POSITION WANTED AS WORKS maintenance engineer, office or sales engineer, mechanical. Can handle large ojbs as well as men and systems.

B-932: POSITION WANTED AS STRUCTURAL Engineer, field or office. Experience, 9 years.

B-931: POSITION WANTED IN DESIGNING, detailing, estimating steel and concrete, including coal tipples.

B-930: POSITION WANTER IN INDUSTRIAL engineering and management, illuminating engineering or electrical maintenance. Experience, 14 years as executive, electrical and mechanical engineer, drafting, accountant, statistician, designer, economist, plant construction an doperation.

B-929: POSITION WANTED AS ASSISTANT to factory superintendent or superintendent of construction (power plant work), or sales engineer, mechanical. Experience, 8 years in above work.

B-928: POSITION WANTED AS INSTRUMENTMAN or draftsman. Experience on R. R. track elevation work and valuation, drafting and designing on concrete work and concrete products plant.

B-927: POSITION WANTED AS ASSISTANT to vice-president, assistant to consulting engineer or sales engineer by gradaute M. E. Experience on inspection and building, also sales engineer, steam specialties for power plants.

B-926: POSITION WANTED AS SALES ENGINEER in hosting machinery or heavy contractors' equipment. Five years' selling experience.

B-951: POSITION WANTED AS ENGINEER on concrete construction or sales engineer, railway equipment or supplies. Graduate engineer, 14 years' experience on railway construction, maintenance and water supply.

Record of Technical Meetings

Herewith find the minutes of meetings held by the Society from October, 1920, to and including Dec. 13, 1920. Publication of these minutes has been withheld because of other important matter. The next issue will report these meetings up to the current month.

The members will be interested in reading these minutes and observe the large number of important subjects which are presented by our Society. I do not know of any other society that covers such a wide range of subjects or which has more able speakers. If you wish to know what you miss by not attending, look over this list. Subjects outside of your own specialty can be more useful to your progress than those in which you are directly engaged.

It is not possible to publish all papers. They are kept on file and can be examined by all members who care to ask for them.

EDGAR S. NETHERCUT,
Secretary.

Oct. 5, 1920 — No. 1093

The Telephone, Telegraph and Radio Engineering Section held its meeting Tuesday, October 5, 1920, Mr. Frank F. Fowle, chairman, presiding. Mr. Montford Morrison, Research Engineer, Victor Electric Corporation, Chicago, presented a paper, his subject being "An Analytical Discussion on Wave Distortion Apparatus." There were in attendance 103 members and guests of the Society.

Oct. 11, 1920 — No. 1094

The meeting of the Bridge and Structural Section was held Monday, October 11, 1920. Mr. Philip L. Kaufman, Contracting Engineer, Strauss Bascule Bridge Company, Chicago, presented a paper on "Some Interesting New Bascule Bridges at Home and Abroad," which was illustrated with lantern slides.

Oct. 18, 1920 — No. 1095

At the meeting of the Hydraulic, Sanitary and Municipal Engineering Section held Monday, October 18, 1920, Mr. M. G. Barnes, Chief Engineer, Division of Waterways, State of Illinois, presented a paper on "The Illinois Waterway." He brought out the possibilities of water transportation and called attention to the crying need of good terminal facilities. There were 65 in attendance, and Mr. Wm. Artingstall, chairman, presided. Mr. Barnes' paper appears in this issue of the Journal.

Oct. 20, 1920 — No. 1096

The joint meeting of the Electrical Section, W. S. E., the Chicago Section, A. I. E. E., and the Chicago Section, A. S. M. E., was held at Fullerton Hall, Chicago, Wednesday, October 20, 1920. The speaker of the evening was Dr. Charles P. Steinmetz, Consulting Engineer, General Electric Co., Schenectady, N. Y. The hall was crowded and many were unable to gain admission. Mr. J. R. Bibbins, chairman, Chicago Section, A. I. E. E., presided.

Oct. 21, 1920 — No. 1097

The Railway Engineering Section held a joint meeting with the Chicago Section, Signal Division, American Railway Association on Thursday, October 21, 1920, with Mr. H. G. Clark, vice-chairman, presiding. Mr. W. P. Borland, Chief of Bureau of Safety, Interstate Commerce Commission, Washington, D. C., presented a paper on "Automatic Train Control." Mr. W. G. Bierd, President, gineer, Miller Train Control Corporation, Danville, Ill., spoke on the "Problems in Installation of Automatic Train Control." Mr. W. G. Bierd, President, Chicago & Alton R. R., gave a very interesting review of automatic stopping of trains, going back in his experience of forty years and brought out the phase of the failure of the human agency. In the discussion of Mr. Calvin W. Hendrick, President, Automatic Train Control Corporation, Baltimore, Md., he outlined the requirements for a good train control device and the advantages to be gained by its installation. The attendance of 235 members and guests of the Society showed the keen interest displayed in the subject presented. The above papers were published in the Journal, Vol. XXVI, No. 2, February, 1921.

Nov. 4, 1920 — No. 1098

The Telephone, Telegraph and Radio Engineering Section meeting Thursday, November 4, 1920, was attended by 80 members and guests. Mr. S. R. Edwards, vice-chairman, presided. The speaker was Mr. Fred L. Baer, Sales Engineer, Automatic Electric Co., Chicago, who spoke on "Calculation of Quantities of Telephone Trunking Equipment."

Nov. 5, 1920 — No. 1099

The general meeting of November 5, 1920, was devoted to "Ladies' Night." At the informal gathering of 225 members and guests, the program included motion pictures, dancing and cards. Refreshments were served and all agreed that it was a real party. We hope to have more of them.

Nov. 8, 1920 No. 1100

The Bridge and Structural Section was honored at its meeting of November 8, 1920, with the presence of Mr. Charles Evan Fowler, Consulting Engineer, New York, who presented a paper on "The Evolution of Bridge Design." Mr. A. W. Dilling, chairman, presided. The attendance was 62. Mr. Fowler's paper was published in the Journal, Vol. XXI, No. 15, November, 1920.

Nov. 10, 1920 No. 1101

The Gas Engineering Section at a meeting held November 10, 1920, with Mr. C. C. Boardman presiding, listened to S. W. Parr, Professor of Applied Chemistry, University of Illinois, Urbana. His subject was "Fuels of the Future," one of broad interest. Attendance, 50.

Nov. 12, 1920 No. 1102

A joint meeting of the Electrical Section, W. S. E., and the Chicago Section, A. I. E. E., was held at the City Club, Chicago, November 12, 1920, with Mr. A. W. Berresford presiding. The following technical papers were read: "Studies in Lightning Protection on 4,000 volt circuits," by D. W. Roper, Commonwealth Edison Co., Chicago; "Lightning Arrester Spark Gaps," by Chester T. Allcutt, Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.; "Life and Performance Tests of O. F. Lightning Arresters," by N. A. Lougee, General Electric Co., Schenectady, N. Y.. and "Electrostatic Condensers," by V. E. Goodwin, General Electric Co., Pittsfield, Mass. A reception and dinner preceded the meeting, which was the 365th technical meeting of the National Society.

Nov. 15, 1920 No. 1103

A joint meeting of the Mechanical Engineering Section, W. S. E., and the Chicago Section, A. S. M. E., was held Monday, November 15, 1920, with Mr. A. L. Rice, chairman, presiding. There were seventy members and guests present. The paper of the evening was "Utilization of Waste Heat," by G. R. McDermott, Mechanical Engineer, Illinois Steel Company, South Chicago, and F. H. Willcox, Mechanical Engineer, Freyn-Brassert Company, Chicago. The authors showed the successful economy in preventing heat losses in large installations. The paper was published in the Journal, Vol. XXVI, No. 2, February, 1921.

Nov. 18, 1920 No. 1104

The Railway Engineering Section at its meeting held November 18, 1920, listened to a most interesting paper on "Steel Rails," presented by Mr. C. W. Gennet, Jr., M. W. S. E., of Robert W. Hunt & Co., Engineers, Chicago. There were seventy-seven members and guests. The chairman of the evening was Mr. C. F. W. Felt. Among those taking part in the discussion were M. H. Wickhorst, Robt. W. Hunt, W. S. Lacher, W. G. Arn, B. M. Cheney, and J. deN. Macomb. The paper was published in the Journal, Vol. XXVI, No. 3, March, 1921.

Dec. 6, 1920 No. 1105

At the general meeting of the Society held December 6, 1920, nearly one hundred members and guests heard the different angles of "The Commercial Use of the Airplane." Prof. John F. Hayford spoke on "Research Problems;" Mr. Arthur R. Rhenisch on "Recent Progress and Costs," and Mr. Walter Painter on "Commercial Airplane Types."

The Western Society of Engineers for many years has been instrumental in the progress of the airplane and those who attended this meeting expressed the hope that more meetings on this subject would be held.

Prof. Hayford is a member of the National Advisory Committee for Aeronautics.

Mr. Rhenisch is Secretary of the Aero Club of Chicago.

Mr. Painter qualified as an instructor in flying at Brooks Field.

Dec. 9, 1920 No. 1106

The Telephone, Telegraph and Radio Section held its meeting December 9, 1920. The subject for the evening was "The Influence of Commodity Price Movement Upon Public Utility Valuations," by Mr. H. R. Allensworth, Consulting Engineer, Tri-State Telephone Company, St. Paul, Minn.

Mr. Fred L. Baer presided at the meeting, which was attended by twenty-seven members and guests of the Society.

This paper was published in the Journal, Vol. XXVI, No. 4, April, 1921.

Dec. 13, 1920 No. 1107

The meeting of the Bridge and Structural Section of December 13, 1920, was attended by forty-five members and guests of the Society. Mr. A. W. Dilling, chairman, presided. Col. H. C. Boyden, Portland Cement Association, Chicago, gave a paper on "Recent Developments in Concrete." He touched on fine and coarse aggregates, proportioning, water content, slump test, manipulation of ingredients and protection of concrete and also called attention to the Abram's table of proportions, developed by Prof. Duff Abrams, of Lewis Institute, Chicago, which contains one hundred and thirty-five proportions with different combinations of aggregates.

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CHARLES H. MACDOWELL
President 1921-22

JOURNAL OF THE
WESTERN SOCIETY *of* ENGINEERS

Volume XXVI JUNE, 1921 Number 6

NEWS OF THE SECTIONS

Bridge and Structural Engineering Section

At a meeting held May 9, 1921, the following were elected officers for the Bridge and Structural Engineering Section:

J. E. Love, Chairman.
J. C. Blaylock, Vice-Chairman.
Fred G. Vent, Director (three years).
The other Directors holding office are:
C. W. Shepherd, term expires 1922.
H. H. Hadsall, term expries 1923.

Electrical Engineering Section

At a meeting held April 25, 1921, the following were nominated for officers of the Electrical Engineering Section:

M. M. Fowler, chairman.
F. E. Goodnow, Vice-Chairman.
Harold Almert, Director (three years).
S. A. Rhodes, Director (one year).
The other Director holding office is Taliaferro Milton. Term expires 1923.

Gas Engineering Section

At a meeting held May 11, 1921, the following were elected officers for the Gas Engineering Section:

R. B. Harper, Chairman.
C. W. Bradley, Vice-Chairman.
H. E. Bates, Director (three years).
The other Directors holding office are:
W. M. Willett, term expires 1922.
H. H. Clark, term expires 1923.

Hydraulic, Sanitary and Municipal Engineering Section

At a meeting held May 16, 1921, the following were elected officers of the Hydraulic, Sanitary and Municipal Engineering Section:

L. R. Howson, Chairman.
Paul Green, Vice-Chairman.
John A. Dailey, Director (three years).
The other Directors holding office are:
W. D. Gerber, term expires 1922.
A. J. Schafmayer, term expires 1923.

Mechanical Engineering Section

At a meeting held April 18, 1921, the following were elected officers for the Municipal Engineering Section:

G. R. Brandon, Chairman.
A. D. Bailey, Vice-Chairman.
J. D. Cunningham, Director (three years).
The other Directors holding office are:
G. E. Pfisterer, term expires 1922.
F. A. Lindberg, term expires 1923.

Railway Engineering Section

At a meeting held May 2, 1921, the following were elected officers for the Railway Engineering Section:

F. L. Thompson, Chairman.
W. G. Arn, Vice-Chairman.
G. W. Hand, Director (three years).
The other Directors holding office are:
A. G. Shaver, term expires 1922.
G. P. Palmer, term expires 1923.

Telephone, Telegraph and Radio Engineering Section

At a meeting held May 5, 1921, the following were elected officers for the Telephone, Telegraph and Radio Engineering Section:

Stanley R. Edwards, Chairman.
Fred L. Baer, Vice-Chairman.
Edw. H. Bangs, Director (three years).
The other Directors holding office are:
Maurice A. Frye, term expires 1922.
Montford Morrison, term expires 1923.

COMMITTEE PROGRESS REPORTS

DEVELOPMENT COMMITTEE

E. T. HOWSON, Chairman

The answers to questionnaires sent out by the Development Committee are being tabulated in the Secretary's office. Upon completion of this work the committee will hold a meeting to discuss fully the views of the membership on the various activities of the Society. If you have not sent in your reply, please do so at once.

PUBLIC AFFAIRS COMMITTEE

ANDREWS ALLEN, Chairman

The Public Affairs Committee has had the greatest number of meetings and the highest average attendance of any committee of the W. S. E. during the past year. It has shown that the engineer has a big part to play for the public welfare, and its scope will increase as time goes on.

The meetings of the present committee will continue during June at the Chicago Engineers' Club each Monday at 12:30 noon.

To the
Governor and the Members of the
Fifty-Second General Assembly,
State of Illinois,

Gentlemen:

I am directed by the Board of Direction of the Western Society of Engineers to transmit to you the attached report of our Public Affairs Committee, as follows:

"Chicago, Ill., May 16, 1921.

To the Board of Direction,
Western Society of Engineers,

Gentlemen:

The Public Affairs Committee is transmitting a report made by Sub-Committee on Public Utilities, regarding House Bill No. 741, which is designated to radically change the arrangements for regulating the operating of Public Utilities in the State of Illinois.

The Committee believes that engineers, generally, must take the stand that the regulation of Public Utilities should be State-wide or District-wide. The extent of the regulating district depends upon engineering, legal, and fiscal, and not upon political consideration.

We believe that the proposed House Bill No. 741, would be a very harmful piece of legislation. It will result in endless confusion including conflicting jurisdictions and, in some cases, no regulation at all. It abolishes all safe-guards over Civil Service and gives the Commissioners much less to do, and at the same time more than dobuling the total salaries of the Commission.

The Public Affairs Committee recommends that the report attached hereto be approved by the Board of Direction, sent to the Governor and to the membership of the State Legislature, and given all possible publicity.

Respectfully submitted,
(Signed) ANDREWS ALLEN,
Chairman.

This report has been approved by the Board of Direction of the Western Society of Engineers.

Respectfully,
EDGAR S. NETHERCUT,
Secretary.

FOR AN ACT CONCERNING PUBLC UTILITIES

The above mentioned bill now before the Illinois Legislature for passage and an enactment into law, makes radical changes in the present law. It will, if passed, have such consequence on the future of this state, its welfare and its utility service, upon which its welfare largely depends, that every citizen should know what changes are proposed, and what the changes will accomplish. Briefly, the changes proposed by the new law are:

A—NAME, "ILLINOIS COMMERCE COMMISSION:" This name is substituted for "Illinois Public Utilities Commission," and forces a change of name on all records, forms, schedules, reports, etc., now on file or in stock.

The initials "I. C. C.," which will commonly be used on all schedules, legal reports, records, etc., in place of the full name, are already established and published as belonging exclusively to the Interstate Commerce Commission.

The provisions of the Act do not reveal that the purpose of this commission is to regulate commerce, as generally understood, but is restricted to the regulation of public utilities. The name is, therefore, illogical.

The change of name will permit evasion of civil service by abolishment of offices.

B—COMPOSITION: The Commission is to consist of seven commissioners with annual salaries of $7,000 each, and eight assistant commissioners at $5,000 yearly each (Total $89,000) to be appointed by the governor for a period of four years, without restriction as to political party.

The present commission consists of five commissioners with annual salaries of $7,000 (Total $35,000). Thirty-seven states have commissions consisting of three commissioners; six have five commissioners and only one other has seven ocmmissioners. Inasmuch as further provision is included in this bill, so that by means of so-called "Home Rule," the jurisdiction of this commission over cities adopting the Home Rule will be removed, the enlargement of the Commission is not justified.

The 1913 Illinois law provided a term of six years, and that not more than three of the five commissioners should be members of the same political party, and also provided for the progressive appointment of the commissioners, so that there would be a continuous, non-partisan, non-political commission.

In twenty-nine states the term is six years; in two states the term is seven years; one state has ten years, and only eight states have your year terms.

The 1917 Amendment to the Public Utilities bill was in itself a backward step, as it permitted the complete appointment of the commission by the incoming governor, and removed the restriction as to political parties.

C—APPOINTMENTS: The bill provides that employees shall not be included in the classified civil service of the state.

The present law puts all accountants, engineers, experts, clerks and employees (except only heads of departments and others who may be exempted by the civil service commission) under the classified civil service of the state, and subject to the civil service act in force July 1, 1905.

Exemption from Civil Service would permit the governor to make a complete change in the personnel employed under the commission at any time and for any reason.

Furthermore, the bill permits the commission to designate any person to make investigations and to conduct the same as prosecutor without restriction as to salary. This would permit a special prosecutor in each county or city to act as an additional "assistant commissioner."

D—TRANSPORTATION DISTRICT: The bill provides that any utility operated by any "transportation district" or other municipality is taken from under the regulation of the commission, and, further, "the powers conferred by this act upon cities shall not apply to nor control transactions by or with any transportation district organized under the laws of the state.

This means that if this is put into effect in Chicago, the transportation district will not be subject to state, public regulation in any way, and would be also free from city council control.

E—STANDARDS OF SERVICE: The bill provides that rates shall be based upon standards of service, but also provides that, if these standards are not met "the rate shall be adjusted to the service actually rendered."

When the state establishes a standard of service, if reasonable (and in order to be legal it must be reasonable) this standard should be maintained and the utility should not be permitted to maintain a degraded service at a lower price.

This change is a radical departure from the theory of all utility regulation laws existing. It is untried and fraught with possibilities of favoritism of the worst kind.

F—CONVENIENCE AND NECESSITY: A certificate of Convenience and Necessity is required before a new utility can begin operations, but the bill provides that it shall be the duty of the commission to grant a certificate of Convenience and Necessity to a competing company if the service of the operating company is found to be inadequate. The commission is also authorized to revoke certificates previously granted. The bill provides that "No certificate of public Convenience and Necessity shall be construed as meaning a monopoly or exclusive privilege, immunity or franchise."

Under these provisions, where the commission for any reason, satisfactory or ulterior, desires to recognize a monopoly in utility service, it may do so; if, on the other hand, they do permit competition, the condition reverts to the old chaotic state which was so disastrous to utility services in former years, prior to commission regulations."

G—HOME RULE: Article VI provides "Any City exercising powers under this act shall have power to exercise such powers by municipal ordinance, *or otherwise,* as such cities shall determine.

This permits a return to obsolete, discarded and unsatisfactory direct rule by the city council. It does not provide for expert or special regulatory authority other than the city council, and no provision is made for uniformity of standard rate of service or rate of compensation. If any city should appoint an expert supervising body, there would be a duplication of service provided for by the State Public Utility Commission. In all

probability, there would be inefficiency and incompetency permitted in such local appointments.

The elements of good and adequate service and the establishment of just and reasonable rates are matters of engineering study and calculation, and they can never be determined satisfactorily by argument or by popular vote.

A study of the accumulated records of the commission of various states shows that the fundamentals an d the general solutions of the problems of one city are the same as those of another city. Public Utilities are essential to the growth of American cities. A utility, to prosper sufficiently, must be permitted to create credit which will enable it to add yearly sums necessary for the expansion of plant and other investment of public service.

H—PASSES: The Act provides that "any common carrier engaged in the transportation of persons between points within the state, on demand, shall furnish transportation free of charge to the governor, lieutenant governor, secretary of state, auditor of public accounts, state treasurer, superintendent of public construction, attorney general and members of the general assembly while traveling to and returning from the seat of government, and while necessarily traveling on official business."

A more revolting return to the old abuses which were abolished many years ago is hardly possible.

"The engineer is endowed by his profession and the state with specialized knowledge for peculiar and special service, involving the life, safety, comfort and convenience of his own and coming generations." Having special knowledge of and experience in the regulation and conduct of public utilities, and in full realization of civic responsibility, we condemn the proposed enactment of House Bill No. 741. It is misleading in its provisions. It is a return to the various unsatisfactory former utility regulation, or lack of regulation, and practice. It places in the hands of the administration a large appointive power without civil service restrictions.

The change in name would permit the wholesale discharge of the present technical staff of the commission, under the guise of abolishing the office and th substitution therefor of untrained, inexperienced employees for political purposes. It would disrupt any standard of service or rate, and would render of little value the investments of thousands of citizens in the present utility corporations. In place of safe-guarding these investments and increasing the state-wide regulation, it would permit it to disintegrate into uneven and chaotic conditions. The pretense of abolishing the Utility Commission is not borne out by the proposed law.

If abuses outlined above are permissable, it is folly to close your eyes to the obvious.

PUBLIC AFFAIRS COMMITTEE.

ENTERTAINMENT COMMITTEE

A. B. BENEDICT, Chairman.

The Entertainment Committee wishes to call attention to the annual dinner which will be held Wednesday, June 8, 1921, at the LaSalle Hotel, Chicago. It is hoped that the members will turn out en masse and show the world that the Western Society of Engineers is still going strong. We will do our part toward making it an enjoyable evening.

AVIATION COMMITTEE

JOHN F. HAYFORD, Chairman

The Aviation Committee is planning to hold a meeting soon to discuss plans for a trip to one of the nearby Flying Fields. It is planned to give our members an opportunity of studying aviation conditions first hand, and if possible the trip will be made in June.

YOUNG MEN'S FORUM

BENJ. B. SHAPIRO, Chairman

During April and May the meetings held by the Young Men's Forum have been of a general character. On April 16, Mr. Edgar A. Greenebaum talked on "Real Estate Loans." Mr. Greenebaum explained every stage in the progress of a loan and how such were accomplished. April 23rd Mr. Meyer Fridstein of Fridstein & Co., talked on the "Future of Engineering." Mr. Fridstein displayed in histalk a knowledge of the future of the engineer, which was startling. His extreme analysis of the why, what, and wherefore of the engineer is the result of intense study. On May 14th, Mr. E. A. Hintz, assistant cashier of the Peoples Trust and Savings Bank, told all about Every-Day Banking. All these meetings have been very instructive and every one who has attended has expressed his appreciation of the time taken. This meetingwas the last one of the year and the present chairman wishes to express his thanks for the hearty co-operation of all those who have been interested. As is usual, the Young Men's Forum has selected their own chairman for the ensuing year. Mr. John A. Dailey has been selected as chairman for 1922.

June Program

June 1, 1921—7:00 P. M. Annual Meeting.
It is recommended by the Board of Direction that an adjournment be taken to the Annual Dinner to be held June 8, 1921.

June 2—7:00 P. M. "Automatic Switching of Toll Traffic," Arthur Bessey Smith, Chief Research Engineer, Automatic Electric Co., Chicago.
Long Distance dialing will be dealt with by one who is in position to speak with authority.

June 6—7:00 P. M. General Meeting of the Society, combined with the Electrical Section, W. S. E., and Chicago Section, A. I. E. E.
"DUST EXPLOSIONS," David J. Price, Engineer in Charge Development Work, U. S. Department of Agriculture, Bureau of Chemistry.
Mr. Price will cover the subject fully as it relates to Dust Explosions in various lines of our American industries, with special relation to the recent explosion at the Armour Elevator. Mr. Price will illustrate his lecture with models.

Annual Dinner
Wednesday, June 8th, 1921

SPECIAL ANNOUNCEMENT WILL BE MAILED TO THE MEMBERS

June 20—7:00 P. M. "The Secret Part of Motion Pictures and Winning the War." Mechanical Engineering Section, W. S. E., combined with the Chicago Section, A. S. M. E.

PERSONAL NOTES

Ten of about twenty-seven known and living assistants and associates of Mr. John B. Berry, Division Engineer, M. of W., working for the Chicago & Northwestern R. R. during the '80's, met at the Chicago Engineers' Club on March 19th and organized a permanent get-together club.

The following were present and were made charter members: Messrs. E. F. Potter, L. P. Yale, Frank Berck, A. Huey, J. W. Harris and E. R. Shnable. Mr. Berck was elected chairman and toastmaster and Mr. Yale as secretary and treasurer.

R. C. Smith, M. W. S. E., has opened an office as Consulting Engineer, 1206 Tribune Building, Chicago. Mr. Smith specializes in examinations, tests and reports on soil conditions, and has many years been Superintendent of Construction for E. C. and R. M. Shankland.

Walter A. Shaw, M. W. S. E., for a number of years engineering member of the Public Utilities Commission of Illinois, announces his return to practice as a Consulting Engineer, with offices at 30 North LaSalle street, Chicago.

Mr. Shaw will give particular attention to public utility rate cases, reports for banks and investors, public utility and personal management, operation and construction, and all branches of municipal engineering and construction work, including designing and supervision.

Ernest Lieberman, M. W. S. E., Samuel Klein, M. W. S. E., and Peter L. Hein, M. W. S. E., announce that the co-partnership heretofore existing under the firm name of Lieberman, Klein & Hein has been dissolved by mutual consent. Messrs. Lieberman and Hein will continue to carry on the business heretofore carried on by Lieberman, Klein & Hein at 190 North State street, Chicago, and Mr. Samuel Klein will engage in the business of rendering engineering services at Suite 606, 130 North Wells street, Chicago.

Alex R. Webb, Moscow, Idaho, has accepted the position of Professor of Civil Engineering, University of the Philippines, Manila, P. I., and is preparing to leave for his new duties.

Mr. Webb has been Professor of Civil Engineering at the University of Idaho for some time.

Clayton O. Billow, M. W. S. E., announces the removal of his business office to 412 Orleans street, Chicago, where they will continue their services as engineers, under the name of the National Supply Company, specializing in problems wherein the combustion of fuels is involved, and the designing and erection of furnaces, forges, kilns and ovens, together with appliances for the storing, controlling and burning of fuel oil. These devices are known as the Billow System.

Mr. L. W. Wallace, Executive Secretary, and Mr. W. W. Varney, Treasurer of the American Engineering Council, paid a visit to the Western Society of Engineers recently.

Plans for corporation are under consideration.

CURRENT ENGINEERING ACTIVITIES

Armour Branch W. S. E.

At a meeting of the Armour Branch, W. S. E., held March 2, the following officers were elected:

President—R. F. Campbell.
Vice-President—H. A. Peterson.
Treasurer—H. Michiels.
Secretary—E. M. Seaberg.
Assistant Secretary—V. Hamacek.
Faculty Member, Board of Managers—Prof. M. B. Wells.

On March 21st the retiring president, Roy M. Singer, gave a short talk on "A Cultural Education Versus a Technical Education," and Mr. Campbell, the incoming president, spoke on "The Status of the Engineer."

On April 4, Mr. Fred H. Avery, Bridge Maintenance Engineer, City of Chicago, gave an illustrated talk on maintenance of bridges in the city which was both interesting and instructive. A series of talks to be given by prominent engineers is scheduled for the balance of the school year.

American Institute Mining and Metallurgical Engineers

Mr. Edwin Ludlow, President, and Mr. Bradley Stoughton, Secretary of the National Society, recently paid a visit to the Chicago Section, A. I. M. E. The officers of the local local Section entertained at luncheon at the Union League Club, Mr. L. V. Rice, chairman, presiding.

Mr. Stoughton had a very interesting report of the acticities and successes of the Institute. Mr. Ludlow gave an excellent address on the future of engineers and their relation to public matters. He stressed the opportunities before the American Engineering Federation as the outstanding feature of organization.

Executive Chosen for Armour Institute of Technology

The Board of Trustees of the Armour Institute of Technology has announced the appointment of Howard M. Raymond as Acting President of that institution to fill temporarily the vacancy caused by the redent death of Dr. F. W. Gunsaulus.

Acting President Raymond is a graduate of the University of Michigan, and is well known professionally throughout the Middle West. He has been connected with the Institute for the past twenty-six years, and has served as Dean of Engineering since 1903.

His thorough knowledge of the steady development of the Institution to its present high standing in the engineering field, and his clear conception of the future needs in engineering education, assure the uninterrupted fulfillment of the plans and policies of the Armour Institute of Technology.

A. S. M. E. Spring Meeting Chicago

At the time of going to press with this issue of the Journal, the Spring Meeting of the American Society has just closed its session with a most successful program. Over a thousand members attended. The opening meeting on Monday, May 23 at the Congress Hotel, Chicago, started off with a zest that did not let up during the entire convention. The mornings were taken up with the technical program while the afternoons were devoted to excursions to various Chicago plants. These included trips to Fisk Street Station, Commonwealth Edison Company, Sears, Roebuck & Co., Illinois Steel Company, Pennsylvania Terminal, Crane Company, Mandel Brothers, Chicago Mill and Lumber Co., Western Electric Company, The Pullman Company, and the Chicago Underwriters' Laboratory.

The program for Wednesday, May 25, was under the auspices of the Chicago Section, A. S. M. E., in co-operation with the Western Society of Engineers. Mr. F. K. Copeland presided. The papers presented at this meeting were on the subject of Chicago as a Mid-Interior Rail-Water Gateway, and were printed in the May issue of the Journal.

Much credit is to be given to the officers and committees for the splendid program, both technical and otherwise. It is hoped that we may in the future have the pleasure of meeting with other national engineering societies in Chicago.

FROM THE SECRETARY'S OFFICE

Edgar S. Nethercut, Secretary

Report of Judges of the Election

The polls closed at noon on May 4, 1921, for balloting on the officers for the Western Society of Engineers, 1921-1922. The result of the ballot was given to the Board of Direction at its special meeting held on that date and is as follows:

Total ballots received		1152
Void, no signature	32	
Non Corporate	27	
Delinquent	10	
Defective	5	
Total void deducted	—	74
Total Ballots counted		1078
For President:		
Charles H. MacDowell	933	
W. W. De Berard	142	
Total	——	1075
For First Vice-President:		
Julius L. Hecht	902	
F. J. Postel	167	
Total	——	1069
For Second Vice-President:		
Frank F. Fowle	986	
For Third Vice-President:		
Benjamin B. Shapiro	968	
For Treasurer:		
Homer Niesz	809	
Robert Isham Randolph	262	
Total	——	1071
For Trustee (3 years):		
E. W. Allen	933	
Albert W. Dilling	131	
Total	——	1064
For Member Washington Award Commission:		
Prof. John F. Hayford	1039	
H. J. Burt	1039	
Total	——	1039

(Signed) WM. T. REEVES,
C. B. OFFICER,
LORAN D. GAYTON,
Judges of Election.

Report of Tellers

AMENDMENTS TO CONSTITUTION.

To the Board of Direction,
Western Society of Engineers.

Gentlemen:

The tellers appointed to canvass the ballots on Amendments to the Constitution beg leave to report as follows:

Total ballots received		768
Void, no signature	28	
Void, non-corporate	13	
Void, delinquent	5	
Void, defective	0	
Deduct total void	——	46
Total ballots counted		722
Amendment "A," Dues—		
For	380	
Against	341	
Total	——	721
Necessary for aodption (2-3 total)		481
Amendment "B," Amendments—		
For	616	
Against	104	
Total	——	720
Necessary for adoption (2-3 total)		480

(Signed) G. A. HAGGANDER,
C. W. HAUPT,
MORRIS W. LEE,
Tellers.

In accordance with the result of the ballot, Amendment "A," providing for an increase in dues, was defeated, and Amendment "B," providing for amendments to the Constitution being adopted during the year, was carried.

What Is Your Fad?

The formation of the committees is the immediate problem of the new administration. No work in the Society is more remunerative to the member than service on an active committee. It increases your acquaintance, your prominence and calls attention to your ability in a marked degree.

Naturally, committee work is not technical —it is organization work when leadership is more pronounced than professional ability. Leadership is essential to success, the committee offers opportunities to show your metal.

Selection of men depends upon acquaintance and it is not possible for any board to know all of the members—except as they make themselves known. Have you a fad or a fancy along the line of any present committee work, or some other line of activity for the society? Will you mention it to the Secretary? Will you do so at once?

Our Library

The following is an extract from a letter received from one of our Non-Resident Members who has recently left Chicago:

"I have always regretted that I have been prevented by the duties of my position from exercising more extensively the privileges of membership in this society, but let us hope that now when I will be a visitor in Chicago, rather than a resident, I may have more opportunity to do so. Incidentally, last winter I had occasion to make extensive use of your library, and I wish to here give testimonial that this one service extended to me by the Society has been of exceptional value."

The question naturally arises, Does our membership fully appreciate the facilities and services rendered by the Western Society? It is our Society. It can respond to the demands of its membership because an enlightened membership will see that the Society has the necessary facilities to make such responses.

Acknowledgement

The Western Society of Engineers acknowledges with thanks the following framed photographs recently received for use in the Society rooms:

Airplane view, showing Astoria plant of the New York Consolidated Gas Company. The Bartlett-Hayward Company, of Baltimore, Md., is the donor.

The Westinghouse Electric and Manufacturing Company supplied two framed photographs, showing the new Chicago, Milwaukee & St. Paul Railway electric locomotive and the New York subway power house.

The General Electric Company gave a framed photograph, showing the New York Central Twentieth Century Limited hauled by an electric locomotive.

EDMUND T. PERKINS

Edmund T. Perkins, M. W. S. E., president of the Edmund T. Perkins Engineering Company, with offices in the First National Bank Building, died suddenly Saturday evening, May 21, in his room at the University Club. Mr. Perkins was born in Scottsville, Va., in 1864, and was widely known. He was engineer for the United States Reclamation Service from 1902 to 1910. After severing his connection from the Government, he formed the engineering company bearing his name. Mr. Perkins was chairman of the Inland Waterways Committee and a member of the Western Society of Engineers since 1910.

A. SORGE, JR.

Adolph Sorge, Jr., M. W. S. E., died suddenly May 5th, 1921. His death was a very distinct blow to the large number of friends which he had in the Western Society of Engineers.

Mr. Sorge was born September 28th, 1857. He graduated from Stevens Institute of Technology, degree of Mechanical Engineer, 1875. From graduation until 1894 he was engaged in various activities in the East. In 1894 he came to Chicago as Superintendent of Frazier & Chalmers Works. In 1895 he opened an office as Consulting Engineer in Chicago and later he organized a company bearing his name and engaged in handling steam specialties.

Mr. Sorge was a member of the American Society of Mechanical Engineers, having joined that Society in 1886.

SAMUEL E. TINKHAM

Mr. Samuel E. Tinkham died in Boston, Mass., April 21, 1921. He had served as Secretary of the Boston Society of Civil Engineers for over forty years. During this time he had retained his professional duties with the Public Works Department of the City of Boston.

The Boston Society of Civil Engineers is the oldest engineering society in America, having been founded in 1848.

Mr. Tinkham was a constructive force in his society, and an inspiration to all who knew him.

M. P. WILLIAMS

M. P. Williams, M. W. S. E., died May 14, 1921, from injuries received while on construction work in Chicago. Mr. Williams joined the Western Society of Engineers December 13 ,1919. He leaves a widow and child to mourn his death.

MEMBERSHIP MATTERS

NEW MEMBERS

At the meeting of the Board of Direction, held May 16th, 1921, the following new members were elected:

17 William C. Schroeder, 4 Avenue A, East, Bismarck, N. D. .... Member
33 William C. Weaver, 410 West 41st Place, Los Angeles, Cal. .... Associate
34 Karl Udet, 4913 Winthrop Ave., Chicago (Transfer) .... Associate
35 Leo Krumdich, 3654 South Robey Street, Chicago, Ill. .... Junior
36 H. M. Goodman, Honolulu, Hawaii (Transfer) .... Member
38 Alva Harold Perkins, Camp Grant, Ill. .... Member
39 James M. Montgomery, 3743 Costello Ave., Chicago, Ill. .... Student
40 George A. LaRue, No. 408 City Hall, Chicago, Ill. .... Member
41 Henry Frederick Hebley, 741 Belden Ave., Chicago, Ill. .... Associate
42 Herman W. Mueller, East Chicago, Ind. .... Junior
43 Peter M. Larsen, Chanute, Kans. (Transfer) .... Member

APPLICATIONS RECEIVED

Applications for membership were received by the Board of Direction since its meeting held April 18, 1921, as follows:

44 Lester C. Bush .... San Francisco, Cal.
45 William H. Roney, Jr. .... St. Charles, Ill.
46 Frank Wolf .... Chicago, Ill.
47 K. M. Whitehead (Transfer) .... Chicago, Ill.

Members are requested to communicate with Secretary with regard to qualifications of the above applicants for membership in the Society.

EDGAR S. NETHERCUT, *Secretary.*

ENGINEERING EMPLOYMENT

We wish to assist in placing valuable men in the employment most suited to them. Many concerns have positions open now or will have in the near future. What could be more logical than an engineering employer obtaining assistance from an engineering society, or an engineer looking for a position to seek a source that is in close tough with the engineering profession? You can co-operate by communicating with the Secretary's Office.

POSITIONS WANTED

B-950: POSITION WANTED IN RAILROAD, Industrial or Highway Work. Experience, 17 years drafting, estimating, field and supervision, including resident and division engineer. What have you to offer?

B-949: POSITION WANTED BY GRADUATE C. E. having 20 years' experience office and outside work in roadway, construction, bridges, buildings, land valuations and contracts.

B-948: POSITION WANTED AS DESIGNER or production superintendent. Experience, 12 years in mechanical an d electrical fields. Would like to make connection where there is field for improvement of products or methods and developing new machines.

B-947: POSITION WANTED IN DRAFTING or tracing by young woman with three years' experience.

B-946: POSITION WANTED AS DRAFTSMAN on mechanical drawings and' details—Civil, Electrical, Mechanical and Construction work. Also design and detail sof electrical apparatus

B-945: POSITION WANTED AS ARCHITECtural draftsman or superintendent on building work. Experience, 18 years.

B-944: POSITION WANTED AS SALES ENgineer, advertising or estimates on mechanical equipment or building products. Experience, 7 years.

B-943: EXTRA WORK SATURDAY AFTERnoons and evenings, preferably to take home. Drawing and drafting, computing, designing, surveys. Map drafting, track layouts, structural detailing, checking. Experience, 10 years.

B-942: POSITION WANTED AS DESIGNER of steel structures, checker or squad foreman. Experience, 16 years. Prefer work in Chicago.

B-941: POSITION WANTED AS CONSTRUCtion inspector in Chicago.

B-940: POSITION WANTED AS CONSULTING or supervising engineer with Chicago concern. Prefer office work.

B-939: POSITION WANTED AS ENGINEER or superintendent on construction, maintenance, operation, or track elevation preferred. Experience, 6 years.

B-938: POSITION WANTED AS MECHANIcal draftsman on piping. Experience, 10 years as draftsman, designer, detailer and checker.

B-937: POSITION WANTED IN MECHANIcal of electrical engineering, plant evaluation or efficiency work. Nine years' experience.

B-936: POSITION WANTED—YOUNG MAN 21 years old. Experience, three years on heating and power plant equipment. Wishes work outdoors along mechanical lines.

B-935: POSITION WANTED AS STRUCTURAL designer. Familiar with concrete design. Experience in office and mill buildings, smelter structures, and theaters.

B-934: POSITION WANTED BY GRADUATE C. E. as superintendent of construction or on special investigations, making estimates and plans in connection with water and coaling stations.

B-933: POSITION WANTED AS WORKS maintenance engineer, office or sales engineer, mechanical. Can handle large ojbs as well as men and systems.

B-932: POSITION WANTED AS STRUCTURAL Engineer, field or office. Experience, 9 years.

B-931: POSITION WANTED IN DESIGNING, detailing, estimating steel and concrete, including coal tipples.

B-930: POSITION WANTER IN INDUSTRIAL engienering and management, illuminating engineering or electrical maintenance. Experience, 14 years as executive, electrical and mechanical engineer, drafting, accountant, statistician, designer, economist, plant construction an doperation.

B-929: POSITION WANTED AS ASSISTANT to factory superintendent or superintendent of construction (power plant work), or sales engineer, mechanical. Experience, 8 years in above work.

B-928: POSITION WANTED AS INSTRUmentman or draftsman. Experience on R. R. track elevation work and valuation, drafting and designing on concrete work and concrete products plant.

B-927: POSITION WANTED AS ASSISTANT to vice-president, assistant to consulting engineer or sales engineer by gradaute M. E. Experience on inspection and building, also sales engineer, steam specialties for power plants.

B-926: POSITION WANTED AS SALES ENgineer in hosting machinery or heavy contractors' equipment. Five years' selling experience.

B-951: POSITION WANTED AS ENGINEER on concrete construction or sales engineer, railway equipment or supplies. Graduate engineer, 14 years' experience on railway construction, maintenance and water supply.

Engineering Employment, Continued

POSITIONS WANTED

B-980: POSITION WANTED AS PRODUCTION, Industrial or Sales Engineer by graduate M. E. Armour, 1916. Experience four years, covering broad mechanical field.

B-979: POSITION WANTED IN SALES OR Office Work by graduate M. E. Michigan, 1900. Thirteen years in one position.

B-978: POSITION WANTED IN ELECTRO-metallurgical plant using electric furnaces, or in small manufacturing plant where mechanical electrical experience can be utilized.

B-977: POSITION WANTED BY GRADUATE Electrical Engineer, Armour 1917, as equipment engineer or any position leading up to engineering sales.

B-976: POSITION WANTED IN THE ELECTrical field, Chicago or vicinity, by student who will be available during June, July and August.

B-975: POSITION WANTED IN MECHANICAL and electrical executive position or testing. Would consider technical writing or general literary work. Experience includes assistant professorship in steam engineering.

B-974: POSITION WANTER IN POWER plant design or assistant to consulting engineer. Experience three years as above.

B-973: POSITION WANTED AS DRAFTSMAN, mechanical or electrical. Seven years experience including electrical operating work.

B-972: POSITION WANTED AS STRUCTUral draftsman. Experience five years.

B-971: POSITION WANTED IN INSPECTION, supervision and reports on public utility properties or industrial plants. Principally mechanical engineering with possibility of application of electriacl. Experience broad, including five years consulting.

B-970: POSITION WANTER AS MECHANIcal draftsman or tracer. Experience six years.

B-969: POSITION WANTED AS CHIEF draftsman, designer, superintendent or estimator. Experience fourteen years including reinforced concrete, flat slab, structural steel and wood.

B-968: POSITION WANTED AS SURVEYOR or outdoor work.

B-967: POSITION WANTED DURING SUMmer in electrical drafting or testing.

B-966: POSITION WANTED AS DRAFTSMAN on special work and machinery during July and August. Experience six years. At present instructor mechanical engineering.

B-965: POSITION WANTED AS CONSTRUCtion engineer, assistant city engineer, or outside civil engineering work. Experience four years. Sewers, waterworks and on general construction.

B-964: POSITION WANTED AS COMBUSTION maintenance or power engineer. Experience twelve years.

B-963: POSITION WANTED AS CHIEF, OPerating or maintenance, ice plant construction or operation, also electrical construction work. Experience sixteen years.

B-962: POSITION WANTED AS MECHANICAL draftsman, detailer or letterer. Experience in heating, plumbing, power plants and conveyors, foundries.

B-961: POSITION WANTED BY CIVIL ENGIneer at present employed by large railroad. Wishes to locate in Chicago or vicinity account wife's ill health.

B-960: POSITION WANTED AS REFRIGERAtion Engineer, executive in manufacturing plant or maintenance engineer in power plant.

B-959: POSITION WANTED AS DISTRICT highway engineer, superintendent on sewers, water, or municipal work. Experience twenty years as engineer in charge of construction, sewers, waters and paving work.

B-958: POSITION WANTED IN BUILDING design or ocnstruction by graduate architectural engineering course. At present employed away from Chicago but is looking for a local connection.

B-957: POSITION WANTED WITH CONSULTing engineer on municipal, water supply, sewage treatment or hydro-electric development work. Experience seven years in above fields.

B-956: POSITION WANTED AS MECHANICAL engineer or designer on bascule bridges, power plants, waste disposal plants and in general engineering work.

B-955: POSITION WANTED AS SUPERINtendent of construction, architectural or structural draftsman. Experience seven years.

B-954: POSITION WANTED AS ENGINEERing executive, or sales engineering, in good line or can invest with services in engineering company, architect or manufacturing concern.

B-953: POSITION WANTED IN HEATING, ventilating ,plumbing or electrical work. Experience also in mechanical equipment.

B-952: POSITION WANTED AS STRUCTUral designer, concrete or steel. Experience six years. Graduate Armour C. E., 1915.

B-982: POSITION WANTED BY GRADUATE Mechanical Engineer, with experience as draftsman, designer, erection, production, maintenance and sale sengineer in executive capacity or sales engineering.

LIBRARY SERVICE
E. V. SAVAGE, Librarian

Documents as a Source of Information for the Engineer

The documents of the United States Government have come to be an invaluable source of reliable information for the business man. The technical man may also find this source productive of a wealth of material, wide in its scope. Busy, and in need of immediate data, he will many times disregard this source because it is not readily accessible through the usual indexes. A short summary of some of the outstanding subjects may suggest the possibilities in these documents.

Upon being presented with a government bulletin, one reader informed the librarian that he knew more about that subject than the government did. Since such knowledge is not in printed form, it becomes necessary to refer to the government investigation frequently. Many of these publications have the advantage of furnishing a well digested treatise which can be assimilated in a comparatively short time.

In the issue of Mechanical Engineering for February, 121,9 (page 111) will be found a very interesting article on scientific and engineering work of the government. Twc bulletins issued by the Department of Education are useful as guides to the sources of information. They are Bulletin 1918, No. 2 Guide to United States Government Publications and Bulletin 1919, No. 74, Federal Executive Departments as Sources of Information for Libraries.

The Bureau of Mines is furnishing material on the very timely subject of oil. This includes not only methods and equipment, drilling, the problem of water in the wells and extinguishing fires, but also cost accounting for oil producers, design of storage tanks and possibilities of increasing the supply of petroleum, oil recovery, manufacture of gasoline, recovery of gasoline from natural gas, etc. Along the line of economy and efficiency in the use of fuels there is valuable information. The analysis of coals from different parts of the U. S. for a period of years together with methods of sampling are published by this bureau. The results of experiments with the utilization of lignite should be of interest as well as the coking of Illinois coal. The mining statutes of the U. S. have been compiled and are published in this series. One bulletin deals with those of Illinois alone. The Glossary of Mining and Mineral Industry has good reference value. The bulletin on the Diesel engine contains much compact information. The subject of the electric furnace, blast furnace, alloy steels, maganese, recovery of zinc, metallurgy of lead, brass melting, etc., are discussed. Quarrying of rock, sandstone, marble and feldspar and mine tunnelling are also covered. All phases of safety in mines have been investigated. This bureau is co-operating in investigations of the ventilation of tunnels for traffic.

For the engineer the topographic maps and the folios of the Geologic Atlas, published by the United States Geological Survey, are of freqeutn use. From this bureau is given out the most authorative information on the mineral resources of the country based on geologic examinations of the districts of economic interest. These investigations cover the entire range of minerals and related industries. Single bulletins deal with hydraulic mining, divining rod, well boring methods, etc. The subject of surface and underground waters is especially well covered. The source of water supply for municipalities and for power is of engineering interest as is the amount of power available in areas where there is small fuel supply. Reports on the gauging of streams to show maximum and minimum flow may be of use to the engineer engaged in river or drainage work.

Reports issued by the Department of Agriculture have covered the drainage of agricultural lands in the southern states and irrigated lands in the west. Bulletins such as "Flow of Water in Drainage Ditches" and "Capillary Movement of Soil Moisture" have recently been issued by the Agriculture Department. Reports from the United States Reclamation Service cover the large irrigation projects.

The Bureau of Standards publications are of special interest to the engineer. These have covered a wide range. On the subject of steels there are the following titles: Thermal and physical changes accompanying the heating of hardened carbon steels, study of the relation between the Brinell hardness and grain size, Stresses caused by cold rolling of annealed carbon steels, Metallographic features revealed by deep etching of steel, Critical ranges of some commercial nickel steels, etc. Enamels for sheet iron and steel is a bulletin frequently used. Other subjects treated are fire brick, Gypsum, lime, lubricating oils, sand lime bricks, ammonia,

motor truck wheels, glass, etc. A recent bulletin reports on the effect of repeated stresses on reinforced concrete beams. The third edition (1920) of the National Electrical Safety Code has just been received, also the progress report of the National Screw Thread Commission. Circular No. 24, with supplements, contains the list of these publications and will prove of frequent use in the engineering office.

The Bureau of Public Roads, Department of Agriculture, has made available data on the construction and maintenance of highways, kinds of traffic, dust prevention, etc. The soil surveys made by the Bureau of Soils contain valuable information in regard to climate, rainfall, character and value of land. The Weather Bureau reports furnihs data on rainfall and temperatures. Its River and Flood service reports results of gauge readings.

From the Forest Service comes information on the properties, seasoning and preservative treatment of wood. Investigation of dust explosions is an example of another type of work which is being done by the Department of Agrculture.

Public Health Service has published results of some investigations concerning the disposal of industrial wastes, studies of occupational diseases, healthful conditions in industrial plants, etc.

Material from the Engineer Corps which has the most interest for the engineer is that dealing with river and harbor improvements. Older volumes of Professional Memoirs may prove useful in design and construction of locks, etc. The yearly report of tests of metals and other materials made at Watertown Arsenal is of value.

Much interesting material is being sent out by the U. S. Air Service.

Reference is frequently made to the specifications issued by the Navy Department.

The increasing demand from the engineer for material of an economic nature can largely be met with material from the government departments and documents.

This list might be made to include many more subjects of interest to the technical man. In its present length it may serve to suggest the extent of this valuable material which may be had free or at a very small cost.

State Geological Surveys

The engineer interested in obtaining information concerning the geology of a particular section of the country often wishes to know whether the particular states in that area have organized geological surveys. For this reason the following list of such states (taken from Mineral Industry during 1919) is given:

Alabama—University.
Arkansas—Fayettville.
Colorado—Boulder.
Connecticut—New Haven.
Florida—Tallahassee.
Georgia—Atlanta.
Illinois—Urbana.
Indiana—Indianapolis.
Iowa—Iowa City.
Kansas—Lawrence.
Kentucky—Frankfort.
Maryland—Baltimore.
Michigan—Lansing.
Minnesota—Minneapolis.
Mississippi—Jackson.
Missouri—Rolla.
Nebraska—Lincoln.
New Jersey—Trenton.
New Mexico—Albuquerque.
New York—Albany.
North Carolina—Chapel Hill.
North Dakota—Grand Forks.
Ohio—Columbus.
Oklahoma—Norman.
Oregon—Portland.
Pennsylvania—Beaver.
*Rhode Island—Providence.
*(Natural Resources Surveys.)
South Carolina—Columbia.
South Dakota—Vermillion.
Tennessee—Nashville.
Texas—Austin.
Vermont—Burlington.
Virginia—Charlottesville.
Washington—Seattle.
West Virginia—Morgantown.
Wisconsin—Madison.
Wyoming—Cheyenne.

The following volumes have just been added to the Library:

Ninde, W. E.—Design and Construction of Heat Engines, 1920.

Sibley, Robert & Delaney, C. H.—Elements of Fuel Oil and Steam Engineering, 1920.

Moldenke, Richard—Principles of Iron Founding, 1917.

Stanley, F. A.—Punches and Dies, 1919.

Daniels, F. E.—Operation of Sewage Disposal Plants, 1914.

RECORD OF TECHNICAL MEETINGS

In the May issue of the Journal were printed the minutes of meetings held by the Society from October, 1920, to and including December 13, 1920.

The minutes of the meetings from December 13, 1920, to date, are here published:

Dec. 17, 1920 — No. 1108

A joint meeting of the Electrical Engineering Section, W. S. E., and the Chicago Section, A. I. E. E., was held December 17, 1920, with Mr. E. J. Blair presiding. The session was attended by 183 members and guests. The subjects covered were of unusual interest in the electric railway field. In his paper, "Progress in Use and Design of the One-Man Safety Car," Mr. Harry L. Brown, Western Editor, Electrical Railway Journal, pointed out the present status and future prospects of design and utilization in cities where economy and improved service can be obtained. "Train Operation by City Surface Railways" was the subject of Mr. S. B. Way's paper. Mr. Way described the development of transportation vehicles and illustrated his talk with lantern slides showing what had been done in Cleveland, Pittsburgh, Boston, St. Louis, New York and Milwaukee to redesign and convert existing equipment to suit present-day requirements of traffic. Mr. H. A. Johnson, Superintendent of Motive Power, Chicago Elevated Railroads, spoke on "The Economic Aspect of Light Weight Safety Car Operation." Mr. Chas. H. Jones, Electrical Engineer, Chicago, North Shore & Milwaukee Railroad, presented a paper on "Automatic Sub-Stations." Col. Bion J. Arnold told of his early experiences with automatic sub-stations on the Elgin and Belvidere Electric Line and how they overcame their difficulties. This meeting was one of the most successful held by the Electrical Section.

Dec. 20, 1920 — No. 1109

"Investigation of the Water Supply of Small Cities" was the subject of a paper presented by Mr. Wm. Artingstall at the meeting of the Hydraulic, Sanitary and Municipal Section held December 20, 1920.

The importance of properly planning for future needs was well presented. With increased area to serve, added capacity for the original city layout, more factories and better fire protection, Mr. Artingstall pointed out that the source of supply requires most careful study.

The meeting was attended by eighty-two members and guests of the Society.

Jan. 3, 1921 — No. 1110

Horace Secrist, Professor of Economics, and Director of the Bureau of Business Research, Northwestern University School of Commerce, presented a paper at the General Meeting of the Society Monday evening, January 3, 1921. His subject was "The Relation of Statistics to Professional Work and Industry." He pointed out that statistics, properly compiled, are used not only for analyzing past performances, but oftentimes are a basis for forecasting conditions. The author pointed out that the statistics have been and are in disrepute—not because of statistics, but because of statisticians. There were sixty-seven members and guests in attendance. Prof. Secrist's paper appears in the current issue of The Journal.

Jan. 6, 1921 — No. 1111

The Telephone, Telegraph and Radio Engineering Section held its meeting on January 6, 1921. The speaker of the evening was Mr. J. O. Carr, Chief Engineer, The Morkrum Company, Chicago, and his subject on "The Development of Printing Telegraphy" was of unusual interest. The author pointed out the various type of telegraph systems used at home and abroad, their good points and also wherein they were lacking. Mr. Carr's talk was profusely illustrated with lantern slides. There were sixty members and guests present. A moving picture on "Wireless Telegraphy" was shown.

Jan. 10, 1921 — No. 1112

One hundred and fifty members and guests of the Society listened to a most interesting paper by Mr. R. Fleming, Engineer, American Bridge Company, of New York, on the subject, "Reducing the Cost of Steel Buildings." The paper appears in the current issue of the Journal. Through the courtesy of the Illinois Steel Company there was presented a moving picture showing the manufacture of Bessemer and Open-Hearth Steel.

Jan. 12, 1921 — No. 1113

"Public Utility Rates" was the subject of a talk by Mr. R. Mulvaney, of the Peoples Gas Light and Coke Company, at the meeting of the Gas Engineering Section held on January 12, 1921. A three-reel film entitled "The Story of the Coal," furnished by the Peabody Coal Company, was shown at this meeting. Thirty members and guests attended.

Jan. 14, 1921 — No. 1114

Mr. John Foley, Forester of the Pennsylvania Railroad, presented a paper on "The Tie Supply of the Future" at the meeting of the Railway Engineering Section, held January 14, 1921. Mr. Foley indicated the need of conserving our forests and pointed out what tie treating had done for the railroads. The Barrett Company furnished a film on "Tie Treating with Creosote." Fify-two members and guests were present.

Jan. 17, 1921 No. 1115

The Hydraulic, Sanitary and Municipal Engineering Section held its meeting January 17, 1921. A one-reel movie, "Our Daily Bread," showing modern methods of farming, was furnished by the General Electric Company. Mr. Wm. Artingstall, chairman, presided and introduced the speaker of the evening. Mr. P. S. Combs, City Engineer, City of Chicago, who spoke on "Chicago City Water, Past, Present and Future." There were one hundred members and guests present at the meeting.

Jan. 20, 1921 No. 1116

The Railway Engineering Section and the Electrical Section, W. S. E., paid their respects to Col. F. Mears January 20, 1921, when three hundred and eighty members and guests turned out to listen to his address on "Alaska and Its Resources." The talk was profusely illustrated with lantern slides and moving picture films. Alaska is surely an engineer's country and the engineer has done wonderful things there, as was shown by the speaker.

Feb. 3, 1921 No. 1118

The Telephone, Telegraph and Radio Engineering Section had as its speaker Mr. E. M. Fisk, Engineer, Western Union Telegraph Company, New York City, who presented a paper on the "Structural Features of the New Western Union Telegraph Building, Chicago" at the meeting of February 3, 1921. Mr. Fred L. Baer presided and one hundred and seventy members and guests attended the meeting.

Feb. 2, 1921 No. 1119

At a general meeting of the Western Society of Engineers, held on February 7, 1921, Mr. R. C. Marshall, Jr., General Manager, Associated General Contractors of America, spoke on "Engineering Contracts." There were seventy-two members and guests present.

Feb. 14, 1921 No. 1120

The Bridge and Structural Engineering Section of the Society held its meeting February 14, 1921. "Tests of Building Columns Under Fire Conditions" was the subject presented by Messrs. W. C. Robinson, Underwriters Laboratories, Inc., Chicago, and S. H. Ingberg, Bureau of Standards, Washington. The paper was illustrated with lantern slides. Sixty-five members and guests attended.

Feb. 21, 1921 No. 1121

At the joint meeting of the Mechanical Engineering Section, W. S. E., and the Chicago Section, A. S. M. E., held February 21, 1921, Mr. . E. Bolling, Carrier Engineering Corporation, New York, presented a paper on "Air Conditioning." Mr. Bolling pointed out the need for proper air in modern buildings. There were one hundred members and guests present.

Feb. 28, 1921 No 1122

The Electrical Section of the W. S. E. held a meeting on Monday, February 28, 1921, at which there were present two hundred fifty members and guests. Mr. J. R. Bibbins, chairman of the Chicago Section of the A. I. E. E., presided.

Colonel Bion J. Arnold, Past President of the W. S. E., and President of the Air Board of Chicago, described the activities of the Air Board in promoting airplane industry in Chicago and in supplying landing fields for the city.

Colonel Arnold introduced Mr. C. F. Kettering, President of the Dayton Engineering Laboratories, Dayton, Ohio, as speaker.

Mr. Kettering spoke on the subject of "Dependence of Aerial Transport on Electricity."

Probably a no more inspiring or instructive address has been made before the Society in many months. Mr. Kettering is an enthusiast on the subject. He is a good engineer and has courage in undertaking anything that his good judgment approves. He, therefore, is well able to describe the work which has been accomplished in airplane manufacture and design and the possibilities for the future.

This meeting was held jointly with the Chicago Section of the A. I. E. E.

March 7, 1921 No. 1123

At the general meeting of the Society held March 7, 1921, a short business session was held. The evening was then turned over to the entertainment committee, who lived up to their reputation. A smoker, some film fun and refreshments made up the program, which all enjoyed. Ninety members and guests were present.

March 17, 1921 No. 1124

The Railway Engineering Section held its meeting March 17, 1921. Mr. C. F. Loweth, Chief Engineer, C. M. & St. P. Ry., presented a paper on the "Classification and Maintenance of Old Railway Bridges." There were eighty members and guests present.

March 21, 1921 No. 1125

The Hydraulic Sanitary and Municipal Engineering Section held its meeting March 21, 1921, with an attendance of 75 members and guests. Mr. Wm. Artingstall, chairman, presided. Mr. Harrison P. Eddy, Consulting Engineer, Metcalf & Eddy, New York City, addressed the Society on "Sanitation and Sewage Disposal." Such a subject is of especial importance to us in Chicago, and it is difficult to know what our future will be.

Mar. 28, 1921 **No. 1126**

A joint meeting of the Electrical Engineering Section, W. S. E., and the Chicago Section, American Institute of Electrical Engineers, was held March 28, 1921, with an attendance of 128 members and guests. Mr. C. W. PenDell presided. The meeting opened with a moving picture film of three reels called "Queen of the Waves," a story of American navigation from the Indiana canoe to the modern electrically propelled battleship. This film was furnished by the General Electric Company. Mr. David J. Price, Engineer in Charge of Grain Dust Explosion Investigations, United States Department of Agriculture, Bureau of Chemistry, gave a talk on grain dust explosions, after which Mr. Wilfred Sykes addressed the meeting on the subject of "Electric Propulsion of the Merchant Marine."

April 4, 1921 **No. 1127**

The general meeting of the Society held April 4, 1921, brought an attendance of 117 members and guests. Mr. J. L. Hecht presided and after a brief business session regarding amendments to the Constitution relative to changes in Article V, Fees and Dues, and Article XV, Amendments, the meeting was addressed by Mr. W. T. Lawley, Trustee of the Sanitary District of Chicago, on the work of that body. Six reels of moving pictures portrayed the tremendous task from its various angles and was most interesting and instructive.

April 11, 1921 **No. 1128**

At the meeting of the B. and S. Section, held April 11, 1921, about one hundred members and guests were present. Mr. A. W. Dilling, chairman, presided. The program was begun with the exhibition of a moving picture film entitled "The Conquest of the Forest," furnished through the generosity of the General Electric Company. Announcement was made of the receipt of a petition providing for an amendment to Section 7 of the Section Rules, changing the date of the beginning of the fiscal year from the third Wednesday in January to the first Wednesday in June. The Secretary reported the following nominations for section officers: Chairman, J. E. Love; Vice-Chairman, J. C. Blaylock; Director, three years, F. C. Vent and Max L. Loewenberg. Prof. F. R. Watson, Department of Physics, University of Illinois, presented a most interesting paper on "Sound Proofing Rooms." This experiment carried on at the University of Illinois by Prof. Watson, was explained in detail. A description of the Music Hall building at the University was also presented, as well as numerous instances of good and bad acoustics. Prof. Watson described a very interesting device by means of which the wave motion in water, which is analogous to sound waves in air, could be measured by means of moving pictures. The meeting was very instructive to all present.. Among the guests were a number of architects who took the opportunity of meeting and discussing with engineers this subject of large common interest.

April 18, 1921 **No. 1129**

The Mechanical Engineering Section, W. S. E., and the Chicago Section, A. S. M. E., held a joint meeting April 18, 1921, with Mr. A. L. Rice, chairman, presiding. One hundred and eighty-five members and guests were present. The speaker of the evening, Mr. A. D. Bailey, Chief Engineer, Fisk Street Station, Commonwealth Edison Company, presented a paper on "The New Calumet Station—Commonwealth Edison Company."

Mr. Bailey gave a most interesting description of this plant and illustrated his talk with lantern slides. He spoke of the difficulties encountered in their other plants and pointed out how these troubles would be overcome in the Calumet Station. The layout all the way through provides for enlargement of facilities as they become necessary.

April 21, 1921 **No. 1130**

The Railway Engineering Section and the Telephone, Telegraph and Radio Engineering Section held a joint meeting April 21, 1921. The paper by Mr. H. C. Chase, Superintendent Telegraph, A. T. & S. F. Ry., on "Railroad Electrical Communication," was read. The meeting was attended by twenty-two members and guests. Mr. C. F. W. Felt, chairman, Railway Section, presided.

April 25, 1921 **No. 1131**

A joint meeting of the Electrical Engineering Section, W. S. E., and the Chicago Sections, A. I. E. E., A. I. M. E. and A. I. & S. E. E., was held April 25, 1921, with Mr. M. M. Fowler, chairman, Chicago Section A. I. E. E., presiding. The papers of the evening were presented by Mr. Carl Lee, Electrical Engineer, Peabody Coal Company, on "Diversity of Coal Mining Loads," and Mr. W. C. Adams, Electrical Engineer, Allen & Garcia, on "Power Distribution Systems for Coal Mines." The meeting was attended by one hundred and fifty members and guests. A three-reel film, provided by the Peabody Coal Company and the United States Bureau of Mines, was presented on "The Story of the Coal." It was most interesting and instructive.

May 2, 1921 **No. 1132**

"Grant Park and South Shore Developments" was the subject of a paper presented at the general meeting of the Society May 2, 1921, by Mr. Linn White, Chief Engineer, South Park Commission. This paper was illustrated with many lantern slides. The discussion by Messrs. Taylor and Young, of the Chicago Plan Commission, and Mr. E. J. Noonan, of the Chicago Railway Terminal Commission, showed the possibilities of Chicago terminal and park improvements. One hundred seventy members and guests attended the meeting.

May 5, 1921 **No. 1133**

The Telephone, Telegraph and Radio Engineering Section held its meeting May 5, 1921, Mr. Frank F. Fowle, chairman, presiding. Mr. Thomas B. Lambert, of the Engineering Department of the Illinois Bell Telephone Company, presented a paper on "Office Building; Telephone Cable Installations." The paper proved of great interest to the members present, indicating the necessity of careful planning in order to introduce economical telephone wiring installation. Twenty-five members and guests attended.

May 9, 1921 **No. 1134**

W. M. Wilson, Associate Professor, Structural Engineering, University of Illinois, presented a paper on "Problems for Research in Structural Engineering" at the meeting of the Bridge and Structural Engineering Section held May 9, 1921. A moving picture film on the Key West Railway was shown. Forty-one members and guests were present.

May 11, 1921 **No. 1135**

The Gas Engineering Section held its meeting on May 11, 1921, Mr. C. C. Boardman, chairman, presiding. The chairman introduced Mr. H. H. Clark, Consulting Engineer, who presented a paper on "Possibilities of Gaseous Heating." Mr. Clark's address was illustrated by slides showing the application of gas to various industrial heating operations. These were supplemented by a series of slides showing the relative theoretical and actual economics in the use of gas for fuel. The session was attended by twenty members and guests.

May 16, 1921 **No. 1136**

The Hydraulic Sanitary and Municipal Engineering Section held its meeting May 16, 1921, Mr. J. W. Alvord presiding. The paper of the evening was presented by Mr. George W. Fuller, Consulting Engineer, New York City, on "Recent Tendencies in Sewage Disposal Practice." Thirty-eight members and guests attended.

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NEWS OF THE SECTIONS

FIFTY-FIRST ANNUAL DINNER, WESTERN SOCIETY OF ENGINEERS

The Fifty-first Annual Dinner of the Society was held on Wednesday evening, June 8, 1921 in the Red Room of the Hotel LaSalle, Chicago, with an attendance of nearly one hundred members and guests.

A reception preceded the dinner, affording an opportunity for those present to meet one another. In the receiving line were Mr. Copeland, Mr. and Mrs. MacDowell and Mr. and Mrs. Nethercut.

The invocation was given by Dr. William Chalmers Covert, D. D., pastor of the First Presbyterian Church, Chicago.

The music was furnished by Benson's Orchestra and the singing under the leadership of Mr. A. B. Benedict, Chairman of the Entertainment Committee, assisted by the well-known soloist, Mr. George E. Waldo, who with his "Songs of Twenty Years Ago," were important features of the occasion.

Mr. Frederic P. Vose as Toastmaster, lived up to his usual reputation, which will always be remembered by those who have attended Western Society banquets. The program began at 8:30 and was called to order by the Toastmaster.

TOASTMASTER VOSE: I was touched—so were you all—not alone by the demand of Secretary Nethercut for the $3.50, but by that old song "Silver Threads Among the Gold." This is the Fifty-first anniversary of this society. It was born about the same year that I was. I am twin with you. And that sweet old melody called up to memory sacred things, things which I am proud to remember. And looking over this illustrious summary of the Executives who have served you so grandly in the past, you have here a list of men who have heard the challenge of the city, and have nobly met that challenge by giving to this community the best that was in them, professionally and as men.

We honor the memory of those who have gone, and those who happily still abide in our midst, and speaking as a citizen of Chicago, having been born here, I personally acknowledge my indebtedness to the men who wrought valiantly, unselfishly, in the days that are gone.

Of that list, aside from the retiring President and your President-elect, there is but one other present, W. L. Abbott. Mr. Abbott, will you kindly arise and just let us see you. (Applause.)

Our Caruso of the Grand Opera Company has very happily referred to the Bench as resembling in dignity the Supreme Bench, and that called to mind a yarn or two told on the most illustrious Chief Justice that ever occupied the Supreme Bench at Washington. I refer to John Marshall, who was elevated to that Bench by President Adams in 1801, and continued in office until the day of his death, as I recall it, in 1834.

Marshall had a cousin, a Virginian like himself, but they were as different as the poles of the universe, in the political economy which each professed, and Thomas Jefferson hated John Marshall, and he sought to circumvent him in every way, and when Thomas Jefferson became President he sought to overturn the complexion of the Supreme Bench by appointing to it Republicans, whom we now know to be Democrats, quite in line with the Coalition Movement of Monday last. (Applause and laughter.)

Marshall was a man like unto Abraham Lincoln, tall, ungainly, careless of his dress, but possessing one of the most winsome personalities imaginable, and by virtue of the qualities of his heart, as well as of his mind, he persuaded the appointees of Thomas Jefferson to formulate those mighty opinions, that the average lay mind fails to appreciate, that gave to the Constitution its elasticity and life, which Thomas Jefferson, familiar as he was with the Constitution, would never have put into it, had he but had his own way.

And one of the secrets of John Marshall's ability to win the opposition to him, and to make them concur in his opinions, was due to that delightful personality, mixed with conviviality that recalls days now gone,—since the Eighteenth Amendment. (Laughter.)

Those were the dear old days when the grog was commoner than water. The ministers, as Doctor Covert well knows, cheered themselves up and were in the spirit frequently, perhaps continuously. (Laughter.)

It came to this pass, that some rather ugly things were said about the Supreme Court as it was then constituted, particularly during the days when the Court was in conference, and not sitting publicly upon the Bench.

It was said that the grog was so common that they really forgot the mighty things that were before them.

So on one Monday morning the Chief Justice said, very gravely, "My Brethren of the Bench, may we not, with your consent, enter this rule, that hereafter, on Conference Days, the Supreme Court will not indulge in intoxicating liquors except when it rains."

They passed through a dreary wait the remaining days of that week, and when Saturday acme, Chief Justice Marshall said, "Brother Story, will you accommodate me by going to the window and seeing if there are any clouds in the sky?"

And Mr. Justice Story very gravely went to the window and returned with the report that the sun was shining unvexed by any clouds.

That did not satisfy the Chief Justice, and he directed him to go to the street below, and scan the horizon all round about.

He did the bidding of the Chief Justice, and returned and said, "If it please your Honor, there is not a cloud to be seen anywhere. There is no indication of rain."

Whereupon Chief Justice Marshall said, "Mr. Justice Story, that is the most unsatisfactory and illogical opinion you have ever handed down. You, as a Federalist, must know that the jurisdiction of this Court is co-extensive with the vast domain of this country, and under the law of probabilities, somewhere within our jurisdiction at this identical hour it must be raining."

"Sam, bring in the grog." (Laughter.)

On another occasion, Hopkins of Pennsylvania had been requested by the Governor of Pennsylvania to become one of the Justices of the Supreme Court of that state. And he went down to Washington and said, "Mr. Chief Justice, I want to lay this question before you. I desire your advice as to whether I shall accept this position that has been tendered me, and I submit the matter to you, because I recognize that you have attained the acme of judicial distinction."

Chief Justice Marshall smiled and said, "Huh, huh, huh, Hopkins, do you know what the acme of judicial distinction is? It is to look into the eyes of a lawyer for five solid hours when he is arguing before you, and not hear a damn word he says." (Laughter.)

I know that you are all delighted that A. Benedict (a benedict) is the Chairman in charge of the arrangements tonight, permitting the ladies to be present, as I recall a very illustrious occasion some months ago, January, 1920, when I was privileged to be in your midst before, the ladies were not present.

How greatly it adds to the enjoyment and to the delight and to the beauty of the occasion to have the ladies with us, and I would suggest for A. Benedict, and for all benedicts this little toast: "To the Sweetheart."

"Here's to the prettiest;
"Here's to the wittiest;
"Here's to the truest of all who are true;
"Here's to the neatest one;
"Here's to the sweetest one;
"Here's to them all in one;
"Here's to you."

(Applause.)

The worthy Secretary of your organization comes from Evanston, and no occasion in this town is satisfactorily passed without reference to the little city hard by—or the hard city little by. (Laughter.)

There is a dear, good lady, a neighbor of ours, who was about to entertain some friends from Kentucky. And she went up to the Public Library and said to the Librarian, "I want something on Kentucky, something on Kentucky Life." "Here is the Kentucky Cardinal." "No, I don't care for any ecclesiastical potentates," she said. "This one is a bird." "Then certainly I will have nothing to do with it." (Laughter.)

It is rather warm, too warm for real comfort, and the men that you want to hear are here, spoiling to speak unto you.

Frederick K. Copeland comes first. Men, will you ever forget that Marathon occasion when he held that Hoover crowd for sixteen solid hours. True, we had food, but it was nothing as compared with the effervescent spirits which he on that occasion displayed, and we honor his memory—rather, we honor the memory of that occasion. We are not honoring his memory—not yet. (Laughter.) Here's hoping that ninety-nine years will roll over those broad shoulders and nimble brain of his, all unvexed by any thought of dissolution.

But he has a very carefully prepared essay which he is about to deliver, in the style of a "Sweet Girl Graduate," and it is unfair to hold him further from you. Doctor Copeland. (Laughter and applause.)

MR. COPELAND: Ladies and Gentlemen, Members of the Western Society of Engineers, and Guests: Carrying out what the Toastmaster said, it adds very much to all our pleasure that the Entertainment Committee should have decided tonight to have the ladies come and be a part of this meeting.

It perhaps is fortunate that we have as light and airy a Toastmaster as we have, on account of the ladies, because in talking to the Western Society of Engineers, as the retiring President, the topic cannot be a very light one, and unfortunately I have never been able to tell an amusing story in my life. Whenever I have attempted it, I have always spoiled them, so that years of discretion have taught me that it is very much better to stick to the job and to the business in hand, and let men like Mr. Vose give us the light touch.

I am going to read what I have here, because I am anxious to give, from my experience of a year and a half as the Executive Head of this Society, a more or less of a message to the membership.

A year and a half ago, we listened to a remarkably able and scholarly address from our then retiring president, Mr. A. S. Baldwin, on the engineering profession, its history and aspiration, an address that we should read and re-read, on account of its inspiration to us as engineers. Few men have the vision of Mr. Baldwin or the ability to express that vision.

As your now retiring president, I am going to call to your attention your own Society, its aims and possibilities, what it is doing for its members and the community in which it functions, and particularly what your duty is to the Society and yourselves in connection with it. This may seem presumptious and may be unnecessary for a few members, but judging from my own attitude for many years as a member, and my experience of the past eighteen months, it is unquestionably timely to emphasize these matters to the membership at large.

The third oldest engineering Society in the country, organized in 1869 as the Civil Engineer's Club of the Northwest, and incorporated as the Western Society of Engineers in 1881, there is an unbroken record of service to the community and to the profession of fifty-two years. During that period, many of the ablest engineers of the country, men of national reputation, have given liberally of their time and influence to its upbuilding. Starting at a period when the Civil Engineer was the only engineer recognized, the Society has seen the growth of Mechanical, Electrical, Chemical, Structural, and other branches of engineering, including our valued friends and associates, the Architects, all of whom have representation in our Society, and with whom the relation of the Western Society as a center of scientific and engineering activities, is one of its most interesting and valuable developments. There is every reason why this relation should grow steadily more intimate and therefore, more useful, co-ordinating the activity of the national societies through the Western Society, for the betterment of the city and state. Scientific men, acting togeher, because of their training and education, can become a force for good that cannot be overlooked or ignored. There has never been a time when there were so many great problems of vital importance to the community that are strictly engineering, and that require a vigilant, fair and competent study of impartial scientific men to see that the general public is kept informed of the issues and given accurate data to insure their correct solution.

The Public Affairs Committee of your Society, under the able guidance of its Chairman, a past president, Mr. Andrews Allen, has been tireless in its study and investigation of matters of broad public interest during the past year, and has rendered invaluable service toward enlightened understanding of matters that most of us have not time to investigate. There has been a meeting every Monday of the General Committee and many meetings of sub-committees that have had special subjects assigned to thm for detailed and searching investigation. There is no limit to the possibilities of service for our city and county and state, of a society made up of educated men, trained as engineers are to think clearly and act only after all the conditions have been analyzed, and who are free from all influences that might prejudice or warp their judgment. The vision of these possibilities alone should make us all enthusiastic and anxious to help push our Society into greater things for the public welfare.

So much for what the Western Society does and may do for the public. Now, what does it do, or rather, can it do for its members? Do you know that the library of the Society is one of the best scientific libraries in the country, in charge of a librarian thoroughly trained and educated in this special work, and always ready to assist any member (and very often non-members) in reference work in any engineering subject? A count of visitors to the library for the five months from January first, 1921, showed that over forty-eight hundred people used its facilities in that period.

The rooms of the Society are open every weekday and frequently evenings, with a force of employees, including the Secretary and his assistant, all of whom are always ready to serve any member who may call on them. In connection with the office, an employment service has been carried on that has been successful in helping a great many young engineers to find work, even in the trying times of the past year. These things I mention because many members never go to the Society rooms.

There are eight sections that hold frequent evening meetings, at which interesting scientific subjects are presented by papers and discussions. Do you ever attend these meetings? There is one general meeting of the Society held every month. Have you ever attended one of these? Are you so wise in your specialty that you cannot learn anything by meeting and mixing up with men who are leaders in their special lines of engineering, is your acquaintance so wide that it would be of no advantage to know more people in like pursuits?

There are many general and special committees, twenty-four in all, authorized by the Board of Direction which takes up technical subjects of broad interests upon which members may serve and do valuable work, as for instance, Terminals, Water-ways, Aviation; and the Board of Direction is always ready to sanction any special committee that is desirous of studying any scientific subjects.

This gives an opportunity for any group of members to get together and do active work, and an opportunity to get the results of this work before the Society in the form of papers and discussions.

A new and very interesting development has been the Young Men's Forum. This branch of the Society has meetings twice a month, on Saturday afternoons, under the leadership and inspiration of Mr. Benjamin Shapiro. Mr. Shapiro has arranged to have a speaker at each meeting to take up some subject of broad practical interest to the younger men, that is not strictly engineering but which has general educational value. These meetings have also had the great advantage of extending the acquaintanceship of the members.

The awards that are made possible to the membership should be carefully considered, and should stimulate great activity, as the honor of receiving one would be very great. The detail of these awards, information in regard to the various committee activities, as well as a great deal of other valuable information in regard to the Society will be found in the Year Book that will be in your hands very soon.

I think you are all familiar with The Journal. Under our new and increased membership various things have been undertaken. It has taken some time to get these things started. You will recall what has been done in the way of Noon-day Luncheons. The Committee that have this in charge have given us ten Noon-day Luncheons, an innovation in the activities of the Western Society of Engineers, the idea having been to bring us, as engineers, more in touch with the problems of the day. The meetings have been extensively interesting and have been very widely attended. I think it has been one of the most valuable things that the Society has offered and done for the membership.

What is your duty to the Society and to yourselves in connection with it? This is really the great problem. It is a common attitude of members of an organization like this to say, and possibly think, that the Society or its Board of Direction, is responsible for its usefulness to

the members. This is all wrong. It's your society, you are a part of it, its success and its usefulness are what you make of it and what you put into it. You cannot expect to take out and never put in.

Remember, and this message is particularly for the younger men, the most valuable asset any young man can have is the right kind of acquaintance, and the man who is going to make a success in life is the one who is willing to give up an occasional evening to broadening his knowledge of man and things and getting out of the narrow rut of everyday surroundings. It is easy to go home after the day's work is over, much easier than to stay down town for supper and then go to a meeting, but it is just this easy yielding that keeps many a young man from the success he might make, and then he wonders what the Western Society is doing for him.

It is giving us all a splendid chance to broaden our knowledge, to widen our acquaintance, to become an active part of a great power for good, and if we fail to take it we have no one to blame for our failure. Many years' experience with men has shown me that the coming man, the valuable man, is he who gives time to things outside of his daily routine, and who is looking out for opportunities both to broaden himself and to serve others. The past eighteen months have been very important ones in the history of the Western Society; the membership was largely and suddenly increased. This brought in problems that were difficult to solve, but they have been gradually worked out.

The older members will probably think that much of what I have said is old stuff. If so, I ask their forbearance. My desire has been to try and emphasize to the newer members the power of their Society, its great vision, its possibilities for good in the finest sense, and their responsibilities to it; and as it is impossible for any one to know every members of a society of this size, their interests and qualifications, I urge for the new officers and the Board of Direction, that any or every member go to the secretary and indicate the activity he is interested in and the kind of work for the Society he would like to do—to put in more than he takes out. With this spirit and co-operation, the Western Society of Engineers will make a record for service and usefulness that has never been equaled—service first and then only, usefulness in the selfish way to its members.

I wish now to thank the employes of the Society, the secretary and the assistants and the office force, for their cordial co-operation during my service.

I wish also to thank especially the members of the board and of the special committees, who have worked faithfully for the Society, and with its executive officers.

Looking back over the year, there are many things we have not done. There are many, many things to be done, and when this new administration takes hold I have no doubt that with new vision and with wider experience they will lead and carry the Society on to usefulness and effort that we have never been able to attain in the past.

At the election, the ballots of which were counted on May 4, the following officers were elected: President, C. H. MacDowell; first vice-president, J. L. Hecht; second vice-president, Frank F. Fowle; third vice-president, Benjamin B. Shapiro; treasurer, Homer E. Niesz; trustee for three years, E. W. Allen. The Board of Directors consists of the above officers, and E. T. Howson, trustee for one year; J. W. Lowell, trustee for two years; C. B. Burdick, past president; A. S. Baldwin, past president; F. K. Copeland, past president.

J. E. Love was elected Chairman of the Bridge and Structural Engineering Section.

M. M. Fowler was elected Chairman of the Electrical Engineering Section.

R. B. Harper was elected Chairman of the Gas Engineering Section.

L. R. Howson was elected Chairman of the Hydraulic, Sanitary and Municipal Engineering Section.

G. R. Brandon was elected Chairman of the Mechanical Engineering Section.

F. L. Thompson was elected Chairman of the Railway Engineering Section.

S. R. Edwards was elected Chairman of the Telephone, Telegraph and Radio Engineering Section.

Giving up, or rather retiring from, a position of this kind carries with it the feeling of regret at leaving the close association with men with whom I have been thrown in contact, but it carries a great recompense for any service or work that I may have put into the Society in the friendships that I have made and in the valuable understanding I have come to have of the character and talent and ability and civic interest of the men who have directed its affairs.

It gives me great pleasure now, after this period of time, to turn over the responsibility as executive head to an engineer of national reputation, a man, perhaps, who has not been so

well known in the Western Society of Engineers, but whose experience and knowledge and general value is equaled or excelled by no one, Mr. Charles H. MacDowell, our new president. (Applause.)

MR. MACDOWELL: Mr. Copeland, Mr. Toastmaster, Ladies, Members of the Western Society of Engineers, and Guests—Mr. Copeland's reference to me recalls an anecdote brought home by Mrs. MacDowell some years ago, about an old lady who had received a bottle of brandied peaches. In acknowledging the gift—and that was before the time of the Eighteenth Amendment—she not only expressed the appreciation of the peaches, but she certainly did like the spirit in which they were sent. (Laughter.)

The world for some years has been badly upset, and in the language of the Florida Cracker, who wrote us some time last year, in reply to a statement that we were unable to ship something to him: "My great grandfather told me that during the Revolutionary War the world got wobbly on its axle. I know from personal memory that during the Civil War the world got wobblier on its axle. I think from what is happening today that the world is again very wobbly on its axle. But I am sure that if we will give it time that it will be restored to its old movement, and that many of these things which today seem irritating and almost impossible to overcome will seem simple in their solution."

The worry which people have today, and have had for some time in the past, is perhaps well illustrated by a story told of a hog buyer traveling through one of the western states in search of prey, saw a drove of hogs in a field. He looked at them a few moments, and noticed that they were nervous. They were running over to one side of the fence, stopping a moment, and then running, helter-skelter, to another portion of the field, remaining a short time, and again over to another section, and back to where they started. The man hunted up the owner of the hogs, and after having made his trade he said, "Farmer, these hogs act very curiously," and he described how he had seen them moving about. "What is the trouble?" "Well," the old farmer said, "it is this way. When I feed them I knock on the fence with a stick, and now those damned woodpeckers are running those hogs to death."

We are called hither and yon by noises and disturbances and things of that sort, and we don't settle down to a calm pace.

The trail of the engineer goes back a long time, almost as far as we have history. The trained man was doing things in his day which were as remarkable as the engineers and scientists are doing today, perhaps more remarkable because he had less to do with. We have almost lost the power of appreciation of what is going on and what has gone on. We take things for granted. We have little general appreciation of how much the engineer has done and is doing for the world.

Coming into New York harbor, we see that wonderful sky-line. We think it is a fine sight, but we do not appreciate the work, the thought, the planning and the execution which was back of all that you see above the earth at that point, the many things which you know to exist underneath the rivers and underneath the bed rock of New York City.

We take those things as just happening, and we do not really give the mead of praise and appreciation that this work should have. The engineer of the past has, through what you might term "canned engineering information," passed on to the world and to the engineers of today his experience and his accomplishments. The engineer of today is the right hand of the scientist in transforming thought into service. He is not only a creative man, but he is an executive man in carrying out the thoughts and ideas which are evolved in the brains and in the laboratory of the pure scientist. I think that all should salute and bow low to the accomplishments of the engineers of the past and the engineers of today. What is being done in the air, on the surface of the ground, and underneath is remarkable. It is certainly entitled to exceptional appreciation on the part of the rank and file of people who take such accomplishments as a matter of course.

Looking ahead somewhat, and thinking of the younger engineer, I am wondering just what his future work will be; how the ideas and ideals of today in engineering will tie into the responsibilities and opportunities which are bound to come in the very near future to the engineer and probably along broader ways than those that he follows today. Almost every problem has an engineering slant to it. Most problems can best be solved by the engineering type of mind.

Planning the work sheet of the future, co-ordinating the various movements which must occur to solve these problems, the engineer knows it is nonsense for him to fool himself. It will tell in his work, his education, and his instincts teach him to be honest. His business is to analyze, to recommend, and to construct.

In meeting these new opportunities which will come and which, in many instances, have already come, the engineer has to do a little more rather than stop with his engineering decisions and the construction which he may undertake and put through.

You gentlemen know, who used to play golf in the olden days with a gutta-percha ball, that you have to have a rather exaggerated follow-through to get anywhere. With the modern ball, that is not quite so necessary. But the follow-through is a very essential thing in almost everything we undertake.

The engineer will be called upon to do more than engineering, as we understand the term today. He will be called upon to act as administrators of business, using his education and his experience and his mentality to do those things in business and political administration that are done today by people who are not nearly as well prepared and nearly as well fitted for such undertakings.

Lawyers today are doing most of our legislating. They belong to a learned profession. Lawyers are at the head of many of our large industrial corporations. They do the work well, but it does seem to me that in those occupations there is opportunity for the engineering type of mind. The engineer rather plays second fiddle, in a way, in the concert of Modern Business Administration, whereas he at least ought to be first violin. In many instances he ought to be director of the orchestra.

Why should he not do more of this work? I think if the younger engineer will consider that the education which he has is to be used by him for service and for benefit, both to himself and to the public, and will draw away from the sharp lines which now seem to demark the engineer from other men in industry, get over the fence a little bit, and play on the other side of business, feel that he can do more in business than in engineering, that he will make himself felt and that he will have great growth in business administration and in political administration, and that the public will profit tremendously by it. He certainly can deliver the goods, and he, I think, can well do more along the lines of general work than perhaps he has been inclined to do in the times past.

I was talking with Dean Dunham today, head of the Harvard School of Business Administration. The work that is beink done by Harvard is extremely interesting. He told me that they were now having their students go through the Engineering Department of Harvard, taking certain courses in engineering, in order to better fit themselves for business administration. There is a school to develop men for executive positions and for business administration. The educators are already appreciating that the qualifications possessed by the engineers are broad enough to warrant their inclusion in the study of business, and I am quite sure, from what I have observed in my own business life, that some of the most successful and best executives are those who have come up through the technical engineering side of business.

In concluding, I suggest that the engineers can derive great benefit from identifying their local engineering societies with larger societies to carry on the broad work now being undertaken by the engineering federation. The study of waste, which has just been presented by the federation as organized by Mr. Hoover, should prove a great benefit to the public. I feel that we can advance materially the interests of the Western Society and its membership by mixing more and more with the other associations in such work as can more properly and best be carried out by co-operation.

I appreciate fully the honor which has been conferred upon me, and the difficulties which confront me in the coming year.

And I ask and I know that I will get all of the help which the membership can extend. I hope that no one will hesitate in coming forward and bringing to the attention of the Board of Direction ideas which they think would be of interest or benefit to the Society. I would like all of the men, and more particularly the younger men,to feel free to make suggestions, to talk things over, and to feel that they are a dominant part of the membership of the Western Society of Engineers.

I am sure that the Board of Direction and its officers will appreciate and will need all of the help which you gentlemen and all other members of the Society can give. (Applause.)

TOASTMASTER VOSE: Mr. Copeland and Mr. MacDowell, I am sure that the Western Society of Engineers appreciates this valedictory and this salutatory address of each of you.

To you, Mr. Copeland, I can appreciate that the compensations that you have received during your service here are of this character, that you are conscious, as you stand in their midst and contemplate the entire membership of the Western Society of Engineers, that you have contributed your mite to the might of the mass.

Each man starting out in executive office in organizations of this character very quickly comes to comprehend the mighty possibilities of the task, and the splendid accomplishments that lie within the power of the personnel of the membership, and he dreams, he has visions, and he seeks to accomplish and make real these dreams and visions. And then, all too soon, the

termination of his office comes, and his successor is elected, and he feels how fruitless, perhaps, have been his puny efforts as compared with the task that he had in mind.

But I am sure that the members of this Society, Mr. Copeland, pay honor to you in accepting the position, conscious as they are that you have given to this service a wonderful degree of unselfishness; you have not slipped into the easy smoking jacket and the easy slippers, but you have taken on tasks, night after night, that perhaps have been irksome and yet tonight, in looking back upon the happy yesterdays, you are conscious that you have delivered that which the Society expected of you.

And to you, Mr. MacDowell, you are in the apostolic line of a wonderful succession, and this opening address of yours speaks volumes for the capacity that lies latent within you, and which will be brought out, I am sure, and the members are sure, during your administrative year. We all unite in wishing you a very prosperous, successful year of service. (Applause.)

Just before Professor Millikan is called upon we will have some letters and telegrams read by Secretary Nethercut. (Applause.)

SECRETARY NETHERCUT: In addition to the verbal regrets which I have from a number of our members, especially of Past Presidents Bates, Alvord, Burdick, Burt and Allen, Mr. Loweth has written this letter:,

June 6, 1921.

Mr. E. S. Nethercut, Secretary Western Society of Engineers, 1735 Monadnock Block, Chicago, Illinois:

My Dear Mr. Nethercut—I regret that I will be unable to attend the Fifty-first Annual Dinner on Dednesday, the 8th, as I leave the city tonight to be absent the balance of the week.

On this occasion I congratulate the Western Society of Engineers upon the very efficient and excellent work which has been accomplished under the management of President Copeland and his efficient staff of assistants. I am confident that the incoming president, Mr. MacDowell, and those to be associated with him, will continue the good work. Please extend to him and to those to be associated with him my best wishes.

Mr. Frank Fowle was Treasurer last year, and is now Vice-President. Mr. Fowle telegraphs from Worcester, Massachusetts, as follows:

June 7, 1921.

Charles H. MacDowell, Western Society of Engineers, 1735 Monadnock Block, Chicago, Ill.:

"Very sorry that business engagements prevent my attendance at Annual Dinner of Western Society of Engineers Wednesday evening; best wishes to you and the Society for a successful year of service to the membership and the citizens of greater Chicago."

Doctor W. F. M. Goss wires from New York:

June 6, 1921.

Edgar S. Nethercut, Western Society of Engineers, Monadnock Block, Chicago, Illinois:

"Salutations to the officers and members of the Western Society of Engineers. I regret that I can not attend the Society's Fifty-first Annual Dinner."

Mr. Chairman ,in looking over the list of Past Presidents, I am reminded that two of our Past Presidents have died during this past year. I mention, and we honor the memory of Mr. Isham Randolph and Mr. Hiero B. Herr.

Toastmaster Vose, in introducing Dr. Millikan, said: Come we now to the final work to be delivered by a man who came to the University a quarter of a century ago, and who has wrought valiantly during the term of service there. It has been the pleasure of many of you on other occasions to hear the splendid themes developed by Professor R. A. Millikan.

How fortunate is Chicago that in our midst is to be found these two universities, rendering to mankind the magnificent service under the inspiring leadership of men of the standing, capacity and character of Professor Millikan, to whom we now give glad ear. (Applause.)

Note—The address of Dr. Millikan will appear in the Technical Section of the August number of The Journal.

At the conclusion of Dr. Millikan's address Toastmaster Vose said: "It is difficult, Doctor, adequately to express our appreciation of this splendid message of yours, looking, as it does, to the utilities of the present, and to the possibilities of the future. We are your debtors forever and a day.

Your retiring President has given thanks to his associate officers, committeemen and to the able officers who made possible the accomplishments of the past administration.

I wonder, Mr. President, if it would not be in keeping with the spirit of the occasion for some one of the members to call for a rising vote of thanks, and in rising to be dismissed.

PRESIDENT MacDOWELL: I call for a rising vote of thanks.

A rising vote of thanks is extended to Professor Millikan.

Adjourned at 10:45.

COMMITTEE PROGRESS REPORTS

DEVELOPMENT COMMITTEE

E. T. HOWSON, Chairman

ANNUAL REPORT.

Your Development Committee is pleased to present the following report of its activities during the year now closing.

The Committee has concentrated its attention during the past year principally on the preparation of a questionnaire which was designed to secure an expression of opinion from the membership at large regarding present and proposed activities of the Society. This questionnaire was prepared with great care and contains a large number of questions concerning the work of the various departments of the Society. The questionnaire was sent to the membership early in this year, a large number of replies have been received which have been tabulated and which are now in the hands of the Committee for final analysis. These replies furnish an excellent view of the attitude of the members towards the many questions confronting the Society.

The Committee hopes to complete its analysis and to prepare its conclusions and its recommendations in time for presentation of the incoming Board of Direction at its first meeting.

YOUNG MEN'S FORUM

BENJ. B. SHAPIRO, Chairman

ANNUAL REPORT

The need to humanize the engineer and enable him to function freely, not only as a machine, but as a unit in the great structure of society, is a necessity.

The Young Men's Forum of the Western Society of Enginers is in a small way attempting to fill this need. Organized over three years ago, the first objective was the discussion at a round table of the affairs of the Society, from the point of view of the younger members. It was felt that Social Progress had given rise to various problems peculiar to the younger men of the organization,, and that an intimate discussion thereof with the idea of formulating definite conclusions for the submission to the Society as a whole, would be beneficial to all. Successful from the start, the subjects discussed at these meetings gradually increased in range until they had entirely outgrown their original scope ,and have a particularly instructive and broadening trend, until today the Young Men's Forum is an active and influential body in the affairs of the Western Society of Engineers.

On the second and fourth Saturday afternoons of each month, in the Society rooms, a group of from forty to sixty men gathers. They are all young—either in spirit or years, and an attempt is made to find out what is of vital interest to the members attending, and capable speakers both inside and outside of the engineering profession ,have appeared before the Committee and discussed that particular subject.

A brief resume of the speakers who have appeared before the Committee during the past one and one-half years is as follows:

F. M. Carroll, General Supt., Hollabird & Roche—"Inter Relation of Engineer, Contractor and Architect."

Wm. H. Britigan, of the Wm. H. Britigan Organization—"Real Estate and the Engineer."

E. T. Howson, Editor of Railway Age—"Engineer in Editorial and Sales Field."

Benjamin Bills, Continental and Commercial National Bank, Trust Dept.—"Public Speaking as Applied to the Engineer."

H. P. Gould, Efficiency Magazine—"Engineering Efficiency."

W. H. Fogarty, Alexander Hamilton Institute—"Right Habits of Mind Are More Important Than Knowledge."

O. M. Fox, Engineering News Record—"Economics and the Engineer."

S. H. Moore, Director of Welfare and Pensions, Peoples Gas, Light & Coke Co.—"The Engineer from the Human Standpoint."

Harwood Frost, President, Brown Portable Conveyor Co.—"Engineering Literature."

Benjamin Bills, Continental & Commercial National Bank—"Face Values For Your Ideas."

C. J. P. Lucas, President, C. J. P. Lucas Company—"Foreign Trade Opportunities for the Engineer."

E. H. Dee, S. W. Strauss Investment Company—"Financing of Building Construction."

F. J. Thielbar, Hollabird & Roche—"Specifications."

E. N. Greenbaum, Greenbaum Sons Bank and Trust Co.—"Real Estate Loans."

Meyer Fridstein, Fridstein & Co.—"Future of Engineering."

E. A. Hintz, People's Trust and Savings Bank—"Everyday Banking."

In this work the Young Men's Forum has had the full support of the Board of Direction. An attempt has always been made to secure the attendance of some of the Board at our meetings, and we were successful, inasmuch as at two of our meetings we have been favored by the attendance of your members—one as a speaker and the other as a visitor.

As from the younger ranks must come the future development of the Society, it should be the duty of the members of the Board to interest themselves in the affairs of the young men ,if the Society is to develop along progressive lines. It is our aspiration to become a regular section of the Society.

The subjects discussed and the personnel of the speakers have been of such character to command the attention of any engineer who aspires to get away from the proverbial rut of the engineer into which he is accused of hibernating.

The young men have selected their chairman for the coming year. The work will be carried on in a bigger and broader scale, and in this we earnestly solicit the hearty cooperation of all the members of the Western Society of Engineers, particularly the Board of Direction.

RECEPTION COMMITTEE
JOSEPH E. LOVE, Chairman

ANNUAL REPORT.

The Chairman of the Reception Committee has made the following suggestions for consideration in the appointment of the Committe for the coming year:

First: That the members of the Committee be selected from the active and interested workers in the various sections of the Society. Further, that one member in each section should be charged with the duty of having at each meeting in his section a well-instructed Reception Committee. In this way the work will not fall upon just a few members of the Society and would in all probability be taken care of in the proper manner.

Second: That a system of permanent name tags be considered, that is, each member be furnished with a button with his name thereon. These buttons, or badges, can be kept in an indexed rack and would be taken out and worn only during the meetings. The use of the suggested system would eliminate a considerable amount of confusion at the door and permit the members of the Reception Committee to spend their time to the best advantage among the members.

Third: This is not a suggestion from this Committee but only a reminder of the card system which the Secretary has in mind. Inasmuch as this card system would have more than one valuable use the present chairman heartily approves of it.

Since none of the members of the present Reception Committe have taken anything but a passing interest in the work it is suggested that none of them be re-appointed for 1921-1922.

LIBRARY COMMITTEE
I. F. STERN, Chairman

ANNUAL REPORT.

As Chairman of the Library Committee for the period January, 1920, to June, 1921, I wish to present the following summary of the work of the Library.

STAFF.

The Library has been in direct charge of Virginia Savage, Librarian, who completed the third year of service in March, 1921, and Elizabeth Drake, who completes two years of service with the Western Society in October, 1921. Since June, 1920, Miss Drake has been connected with the Library.

Miss Savage is a graduate of the University of Missouri and holds a certificate from the New York State Library School. In addition, she has had nine years of experience in university, public and special libraries. Miss Savage deserves the greater part of the credit for the improvement in the service that has been rendered by the Library during the past year.

EQUIPMENT.

The reorganization of the Library had been seriously hampered for two years by the lack of proper shelving.

Many of the volumes had been given a classification number to indicate the subject matter of the book, but on account of this lack of shelving, it was not possible to arrange them by these numbers. Additional space was also an imperative need.

In April, 1920, steel bracket stacks of the regulation Library standard were ordered at a cost of $635.00 and were installed last August. This allowed a proper re-arrangement of the volumes and brought the greater portion of them together in one section of the rooms. Some of the old book cases were disposed of, but several of them are still on hand awaiting disposal. The re-arrangement also provided additional space for the reading room. During the past few months the seating capacity of this room has not been adequate to accommodate the readers at certain times during the day.

SERVICE.

The work of this particular library is of two distinct types, (1) Daily Library Routine, involving all the work necessary to maintain a library of ten thousand volumes—answering all inquiries, checking and filing current periodicals, caring for new material of all kinds received in library, filing all material used in library, etc., etc. (2) Reconstruction involving classifying, listing, marking of all volumes, withdrawing some material from and incorporating all other material into main collection, completing files, etc., etc.

An effort is made to answer every inquiry which comes to the library. The limited resources of the collection seriously hampers this service. There is absolutely no material in the library on many of the subjects of constant and current interest. A miscellaneous collection of books, received as gifts or at the whim of the publisher will not make a library. There should be a well-balanced selection of material in order to be able to render any useful service. However, we have tried to overcome the handicap of lack of material by special personal service and advising inquirers as to sources of information not contained in our library.

A special effort has been made to obtain suggestions from the membership in regard to the most authoritative material to be added to the collection. This effort has brought excellent co-operation in some cases and in others has met with lack of interest.

An attempt has been made to count the visitors to the reading room and library. Statistics for 1921 are as follows: January, 646; February, 1080; March, 1066; April, 1021; May, 1071; total, 4884. This does not include the service called for many times per day over the telephone.

The increase in the number of engineers using the library has been due in part to the widespread unemployment.

Many technical men have taken advantage of their spare time to make investigations along lines not directly related to their usual work.

Others have used the opportunity to keep in touch with current information. Disregarding the factors that may have caused the increased attendance, it has been demonstrated that, with proper support, the Library has ben developed into a useful tool of the Society, and is susceptible of still greater develonment. It furnishes a service which may be used to attract new members to the organization.

The greatest problem which the Librarian has to face is that of reconstruction. The Library of the Society has never had a catalogue nor any accurate record of the volumes as they stand on the shelves. The Librarian tells me that every third man who makes inquiry asks why we do not have a catalogue. We do not have a catalogue because the making of a catalogue involves an immense amount of detail which cannot be handled in connection with the many demands now made upon the librarian and her assistant. This work can only be done accurately and well by one who has had library school training or experience under a person with such training. It is not clerical work. The finances of the Society do not allow employing the additional help necessary at the present time.

The Librarian is carrying forward the work of reorganization as rapidly as possible in addition to the other work. What librarians call a "shelf list" is being made. This corresponds to a stock list in the ordinary business and will make it possible to take an inventory at any time and to tell exactly how many volumes are in the collection. Old material is being sorted, incorporated into the collection or, when not within the scope of this library, placed in other libraries. Members who are specialists in the particular lines are asked to pass upon any material which is to be disposed of, and decisions regarding such material are being promptly made.

An accumulation of pamphlet and similar material is being organized into a data file.

This work is of a constructive nature and will greatly facilitate any future indexing when the Society is in a position to go forward with that phase of the problem.

FINANCES.

In order to meet the necessity for additional books in the Library, the Committee sent out a request for funds. In response, a total of \$519.50 was received, of which \$93.82 has been spent to date. The Finance Committee asked that this money be spent at a rate of not more than \$35.00 per month. Purchases from this fund have been made on suggestions from various members of the organization, after being referred to the Library Committee.

SUMMARY.

During the past few years the use made of the Library by its members has been gradually growing.

Each year the question of maintaining this Library comes up before the Board of Direction. The Library has been accumulating over a considerable period of time and the Society has been at the expense of rental for snace to house it. There are only two ways of meeting this problem—either dispose of the library or keep it up-to-date and well organized. The past condition was the result of neglect. This year we have done all that could be expected with the funds available for library purposes. Every year that it is allowed to go without proper financial sup-

port means additional expense the following year. It has been repeatedly suggested that the library be made self-supporting. This should be done in the future if possible, but a charge cannot well be made until it is better able to render satisfactory service. Why not value the library as an asset and give it the proper place in the work of the Society? Consistent interest and support can develop from it a service which will be invaluable to every member.

The Chairman of the Library Committee recommends:

1.—Acquisition of needed volumes for the Library.

2.—Definite budget for the Library.

3.—Maintaining of comfortable, well lighted reading room with sufficient number of chairs to accommodate the readers.

4.—Interest on the part of the Board of Direction and the membership in building up the collection.

5.—The suggestion made by the librarian that the personnel of the committee be not entirely changed each year.

NOON-DAY LUNCHEON COMMITTEE

ANNUAL REPORT.

Our Committee on Noon-Day Luncheon Meetings is happy to report a successful series of ten meetings since the first meeting, which was held in April, 1920.

With the present tendency on the part of engineering organizations to interest themselves in other than strictly engineering subjects, it was felt early in 1920 that it would be a very good thing to establish a monthly Noon-Day Luncheon. A committee was organized under the leadership of J. H. Libberton, which proceeded to function immediately. The thought of the Committee was to secure well-known speakers who would discuss subjects of a broader and more inspirational nature than strictly engineering subjects. Though there have been times when it was necessary to substitute for an announced speaker, we have in general been able to keep to the high plane established in the Spring of 1920. All meetings have been held on Friday in the Cameo Room, Hotel Morrison. Attendance has ranged from 150 to 500, with an average of 325.

Your Committee feels that the Noon-Day Luncheon Meetings have given the members a broader insight into general subjects, have made it possible for engineers to take their business associates to gatherings where they realize the broadness of the engineer's outlook, and have received publicity of value to the engineer and to the Society. The Committee suggests that the luncheons be continued, that they be held once a month from October to May, inclusive, and that they be started at 12:15 and adjourned promptly at 1:30.

The following list of dates, speakers and subjects speaks for itself as to the quality of our meetings:

April, 1920—Samuel Insull, President Commonwealth Edison Co., Chicago, Ill; subject, "The Engineer's Influence in Public Utilities."

May, 1920—David R. Forgan, President National City Bank, Chicago, Ill.; subject, "The Present Financial Situation."

October, 1920—Harry H. Merrick, President Great Lakes Trust Co., Chicago, Ill.; subject, "Where Are We Heading?"

November, 1920—E. J. Mehren, Editor Engineering News-Record, New York City; subject, "An Engineer's Impression in Europe."

December, 1920—Dr. George E. Vincent, President Rockefeller Foundation, New York City; subject, "Solving a Community Problem."

January, 1921—Harry Newman Tolles, Vice-President Sheldon School of Salesmanship, Chicago, Ill.; subject, "Salesmanship in Engineering."

February, 1921—Wm. B. Storey, President Atchison, Topeka & Santa Fe Railway, Chicago, Ill.; subject, "The Railroad Problem of Today."

March, 1921—Chas. R. Holden, Vice-President Union Trust Co., Chicago, Ill.; subject, "A Basis for Business Revival."

April, 1921—Dean M. E. Cooley, University of Michigan, Ann Arbor, Mich.; subject, "Engineering Education."

May, 1921—Homer J. Buckley, President Buckley Dement & Co., Chicago, Ill.; subject, "Engineering in Advertising."

Your Committee feels that the above mentioned series of luncheons has given a background for similar future activities and that able speakers can be secured that will talk to the Society on subjects of current interest.

PUBLIC AFFAIRS COMMITTEE

ANDREWS ALLEN, Chairman

ANNUAL REPORT.

The Public Affairs Committee begs to submit herewith the report of its Secretary, Mr. E. H. Verrall, giving a complete account of its activities, from the time of its appointment in January, 1920, up to June 6th, 1921.

The Chairman of the Committee takes this opportunity of expressing his gratitude and appreciation of the work done by the various standing and special sub-committees and their chairmen. We have held meetings

every Monday noon during our term of appointment, and these meetings have been well attended and full of interest.

A great amount of constructive work has been done of which the Secretary's report gives only an outline. It has been our thought that the engineer should study and acquaint himself with public affairs. He is interested as a citizen in all matters of public interest and should have the opportunity of obtaining the results of a thorough, non-partisan study of such questions made by members of his own profession.

We also feel that the public is entitled to the results of such studies, and that on proper occasions, we should not hesitate to exercise such influence as we may possess on the side of good government and of sound engineering and economics.

It would be unfair to give special mention to any of our reports and investigations without mentioning them all and the list given in the Secretary's report is therefore submitted as an account of our year's work.

We pass many unfinished matters to our successors. Among them the following:

An investigation of engineering employment with recommendations as to proper basis of charges for engineering work.

Many important pieces of public work are listed under the assignment to the Public Works Committee.

Report on the Osborn report on garbage reduction in the City of Chicago.

Final Report on proposed Illinois State Housing Bill.

These problems and many other matters now under way, we leave to our successors in office in the hope that they will find in them a wide and important field for investigation and action.

Andrews Allen,
Chairman.

To the Board of Direction,
Western Society of Engineers.

The Public Affairs Committee of the Western Society of Engineers, composed of 10 members, with Mr. Andrews Allen as Chairman, held its first regular meeting in the Engineers' Club, March 15, 1920.

In view of the volume of work before the committee, the organization of six sub-committees was immediately arranged, the division being made into the following subjects:

Illinois Constitutional Convention—J. L. Jacobs, Chairman.

Zoning for the City of Chicago—P. E. Green, Chairman.

Highways—M. L. Greeley, Chairman.

Urban Transportation—H. H. Easterly, Chairman.

Smoke Abatement—Jos. Harrington, Chairman.

Since the organization of these sub-committees ,the following have been added from time to time as occasion warranted:

Sub-committees to investigate the suspension of Messrs. Pihlfeldt and Young from the service of the Bridge Department, City of Chicago—H. J. Burt, Chairman.

Sub-committee to co-operate with the City Council Finance Committee in the matter of the Strauss Bascule Bridge patent suits—John P. Cowing, Chairman.

Public Utilities Commission Sub-Committee—A. P. Allen, Chairman.

Lincoln Park Extension Sub-Committee—H. W. Evans, Chairman.

Public Works Sub-Committee—J. H. Prior, Chairman.

Army Cantonment Construction Sub-Committee—Robert Knight, Chairman.

Streets and Parks Sub-Committee.

Regular meetings of the main body of the Public Affairs Committee have been held once a week since its formation, and until the present date.

Attendance has been remarkably good, considering the obvious demands upon the time of the members of the committee. Sub-Committee meetings have been held at various times during the week in the convenience of the members of each sub-committee.

Early in 1921, and with the prospect of carrying the work and the organization of the Public Affairs Committee over until June, 1921, to correspond with the change in Society Administration, a revision of assignments to sub-committees was effected.

Various temporary sub-committees have been appointed by the chairman from time to time, for the investigation of special subjects not within scope of the permanent sub-committees.

The addition from time to time of members of the Western Society particularly qualified to render opinions on matters before the committee has brought the committee membership to 16.

Public Affairs Committee reports have been made to the Board of Direction of the Society, with suitable requests for action by the Board regarding each report. This action requested of the Board usually included the sending of copies of the Committee's report to the persons or organizations whose actions it was desired to influence; to other persons or organizations interested; in many cases to the daily press; and for publication in the Journal.

Copies of the reports of the Public Affairs Committee with the record of action in each instance are on file with the Secretary of the Society.

A total of twenty-nine reports have been made by the Public Affairs Committee, the titles of which follow:

April 5, 1920—Resolution on Proposed Bond Issues, City of Chicago, Election of April 13, 1920.

April 12, 1920—Recommendations for the consideration of the Illinois Constitutional Convention.

April 19, 1920—Memorandum on the Thompson Traction Plan, City of Chicago.

April 19, 1920—Resolution on the Selection of Cook County Judges, and recommendation to the Constitutional Convention.

May 3, 1920—Revised Recommendations to Constitutional Convention (April 12 report).

May 24, 1920—Resolution to Constitutional Convention on local elections.

May 24, 1920—Resolution on Fifty Ward Plan.

June 21, 1920—Report on Zoning the City of Chicago.

July 19, 1920—Progress report on Urban Transportation.

August 23, 1920—Report "State Regulation vs. Home Rule for Utilities."

August 30, 1920—Report on Proposed Extension of Lincoln Park.

October 18, 1920—Report on Strauss Bascule Bridge suit against City of Chicago.

October 29, 1920—Public Meeting for Discussion of Election Features.

November 1, 1920—Highway Committee Report.

November 8, 1920—Co-operation with Senate Committee on Reconstruction.

November 15, 1920—Progress Report on Cantonment Construction.

November 22, 1920—Report on Proposed Anti-Parking Ordinance.

January 17, 1921—Report on Activities of Mayor on City Transportation.

January 17, 1921—Report on Gen. Black's criticism of water works and sanitary policy of City of Chicago.

January 24, 1921—Report on City Zoning.

February 7, 1921—Report on Suspension of Messrs. Pihlfeldt and Young.

February 14, 1921—Report on Proposed $8,000,000 Bond Issue to pay operating expenses, City of Chicago.

March 14, 1921—Resolution on Investigation into Financial Matters of City of Chicago.—McMurray resolution before Illinois State Senate.

March 14, 1921—Resolution on Zoning.

March 21, 1921—Investigation into appointment of Assistant Chief Engineer Sanitary District.

April 18, 1921—Report on Fees to Experts, City of Chicago.

May 9, 1921—Report on Public Utility Resolution, House Bill No. 741.

June 6, 1921—Report on Investigation into Cantonment Construction Costs.

Report on proposed ordinance for licensing sale of electrical equipment in City of Chicago.

E. H. Verrall,
Secretary.

SUB-COMMITTEES AND SUBJECTS

Public Works Committee:
- Chicago Waterworks System.
- Filling in old Illinois & Michigan Canal and west fork of south branch of Chicago River.
- Financing Special Assessments.
- Chicago Fire Fighting Equipment and Method.
- City Signal System, including Fire, Police and Electrical Department Signals.
- Collection and Disposal of Cities' Waste.
- Street Lighting Extension in partially developed area.
- Reconstruction of Cihcago downtown sewer system.
- Engineering features of health and asnitation—Plumbing Code. New code being written.

City Zoning Committee:
- Development of Chicago's harbor.
- Zoning.
- Chicago Building Heights.
- Chicago Plan.

Traffic and Transportation:
- Double level streets for traffic.
- Control of downtown traffic and alleviating present conditions.
- Parking and handling automobiles in downtown districts.
- Mayor Thompson's 5 cent fare program.

Public Utilities Regulation:
- Computation of fixed charges for government operated utilities.
- Home Rule and Public Utilities Commission.

Parks and Playgrounds:
- Streets and Parks.

Constitutional Convention:
- Present activities of Convention.

Engineering Employment:
- Business Training for Engineers and Engineering Students.
- Compensation of Engineers.

Not Assigned:
- Lectures for general public in Engineering Topics of Public Interests.
- Discussion and interpretation for the laymen of relationship of engineering profession to the public and the ideals and aims of the profession.
- Establishment of close co-operation with government officials and the press with regard to engineering problems.
- Telephone Service Measurements.
- Activities of State and Municipal Engineers in private practice and its relation to their public duties.

Questions on Civic Policy and Engineering which are now being considered by the Public Affairs Committee or which may be brought up for consideration within the near future:

1. Betterments to the Chicago Water Works System.
2. Additional Bond Issues for bridge construction.
3. Fixed Bridges vs. Movable Bridges over the Chicago River and its branches.
4. Filling in of the Old Illinois and Michigan Canal and the West Fork of the South Branch of the Chicago River.
5. Financing special assessment paper under the operation of present tax sale law.
6. Chicago's Fire Fighting Equipment and Fire Fighting Methods.
7. City's signal system, including Fire, Police and Electrical Departments' signals.
8. Development of Chicago's Harbors.
9. Control of downtown traffic and alleviating present traffic conditions.
10. Parking and handling automobiles remaining in the downtown district during the day.
11. The collection and disposal of the city's waste.
12. Street Lighting Extension in partially developed areas.
13. Computation of fixed charges for governmental operated utilities.
14. Reconstruction of Chicago's downtown sewer system.

MEMBERS OF THE PUBLIC AFFAIRS COMMITTEE.

Andrews Allen, Chairman; Paul Green, F. H. Cenfield, A. J. Mason, A. S. Coffin, J. W. Alvord, R. F. Schuchardt, S. O. Dunn, G .C. Nimmons, S. I. Stocking, C. C. Brooks, C. C. Hotchkiss, R. E. Schmidt, M. L. Greeley, J. P. Cowing, W. G. Evans, J. L. Jacobs, H. H. Easterly, S. A. Rhodes, A. P. Allen, Robert Knight, B. D. Barker, E. P. Rich, W. D. Gerber, C. B. Ball, R. F. Kelker, C. L. Mohler, E. J. Noonan, G. A. Quinlan, Frank Windes, G. W. Tillson, G. W. Carr, F. A. Sager, D. J. Brumley, J. V. Sullivan, E. H. Verrall, Joseph Harrington, H. W. Evans, J. H. Prior, H. G. Lothholz, H. J. Burt, W. S. Shields, T. Frank Quilty, G. C. D. Lenth.

PERSONAL NOTES

Woodworth Elected President Rose Polytechnic Institute

The Board of Managers of Rose Polytechnic Institute announced the selection of Dr. Phillip B. Woodworth, M. W. S. E., as president of the Institute, succeeding Dr. C. L. Mees, former president, who resigned in 1919 after twenty-seven years of service.

The election of Dr. Woodworth came as the result of two years diligent search by a committee of the board, during which the merits of a number of professional and scientific men of note have been canvassed. The board believes that in the final selection of Dr. Woodworth it has engaged the services of one fully qualified in every way to carry on the great work which the institute has done during the past 38 years of its existence.

The new president comes to the institute with a record of accomplishment which gives ground for the belief that he will prove a successful leader.

HAS WIDE EXPERIENCE.

Dr. Woodworth was graduated in the class of 1886 with the degree of B. S. from Michigan State Agricultural College; in 1890 he received the degree of Master of Engineering in electrical engineering from Cornell University and later was a student in engineering and science at the University of Berlin in 1891-92. In 1920, his alma mater, Michigan Agricultural College, conferred the honorary degree of Doctor of Science upon him.

His teaching experience began in the public schools of Michigan previous to entering college; upon his return from abroad in 1892 he became professor of physics and engineering in Michigan Agricultural College and in 1899 entered Lewis Institute, Chicago, as professor of engineering and, later, dean of engineering. This position he held until called into government service in 1917. There he was successively executive secretary of the National Council of Defense ,regional director for North Central States in charge of vocational training work for enlisted men, and a staff officer of the war plans division of the general staff without rank, which position he held up to the time of his appointment as president of the Institute. In connection with his general staff work Dr. Woodworth had charge of educational training in the camps in the North Central States, to which were later added Ohio, West Virginia, Kentucky, Arkansas, Kansas, Nebraska, North and South Dakota and all states between North Dakota and West Virginia.

He organized the army school at Camp Grant, which has since been selected as the model school for the United States and the center of the national educational work for the government.

Dr. Woodworth has had wide experience in engineering, in addition to that gained through his teaching. He served as designing and consulting engineer for the Piatt Power company in the construction of a dam at Lansing, Mich., and in the installation of equipment and superintendent of operation for three years; was also managing superintendent of the Lansing street railway for two years. He has been retained in the capacity of an expert consultant by the Chicago surface lines, the People's Gas, Light and Coke company, the Chicago Elevated Railway, the Chicago Telephone company, the Commonwealth Edison company, the Western Electric company ,the Aeolian company of New York, the Christensen Air Brake company of Milwaukee and by numerous other less known corporations. Most of this work was done under the firm name of Rummler, Rummler & Woodworth, attorneys and engineers.

He is the author of a text book, "Engineering Principles," and of numerous technical and educational papers; is a member of the American Institute of Electrical Engineers and a director of the Chicago section of that society; a member of the Western Society of Engineers, having been vice-chairman of the electrical section; a member of the Society of Automotive Engineers, of the Society of Industrial Engineers, of the Engineers' Council (Masonic organization) and of the Chicago Electric club.

He is a member of the following clubs: The University Club, the Cornell Club, the Michigan Club, the Michigan Agrictultural College Club, of the Phi Delta Theta fraternity and of the Dadalion society; also of the honor engineering society, Tau Beta Pi.

A. B. Boyer, M. W. S. E., and A. I. Baum, M. W. S. E., proprietors of the LaSalle Engineering Company of Chicago, have reorganized the firm under the name of Boyer, Baum & Company, and have established offices at 1307 Syndicate Trust Building, St. Louis, Mo., for the practice of Consulting Engineering in connection with structural steel, reinforced concrete and timber structures.

FROM THE SECRETARY'S OFFICE

Edgar S. Nethercut, Secretary

Andrews Allen Fund

The end of the year is rather interesting for the members of the Society to review experiences of the past year.

The Public Affairs Committee has had a very successful year, as will be noted by their report. There has been a rare combination of leadership and ability.

At the Annual Dinner Mr. Copeland presented a letter, which will explain itself as follows:

June 7, 1921.

Mr. Andrews Allen, Chairman,
Public Affairs Committee,
Western Society of Engineers,
Chicago, Ill.

Dear Mr. Allen:

It is with sincere pleasure that by means of this communication we transmit to you on behalf of the Public Affairs Committee of the Western Society of Engineers an expression of great appreciation for having had the privilege of co-operating with you during the past year and a half under your able leadership as Chairman.

We who have had the good fortune to sit in with you at the meetings congratulate you upon the able and impartial manner in which you have conducted the many discussions. The thanks, not only of the membership of the Committee, but also the entire membership of the Society you are truly entitled to.

Under your able leadership the Public Affairs Committee has been established upon a firm foundation, and continuing administrations will be guided by the beacon light of inquiry which you have focused on subjects well worth while for the Society to investigate not only to the great benefit of its membership, but to the benefit of the city, state and country. We congratulate you upon the accomplishments of the Committee during your regime.

To add to our expression of high regard for the able service you have rendered, we wish to show our appreciation by a contribution to the funds of the Public Affairs Committee of the One Hundred Dollars to be used in the interests of the Public Affairs Committee at the discretion of its Chairman.

This contribution is made in the name of Andrews Allen as a token of the esteem in which your valued friendship and able guidance will be remembered by your Committee.

On behalf of the whole Committee we extend our best wishes and hope for your continued health and prosperity.

Cordially yours.
J. L. JACOBS,
H. W. EVANS,
E. H. VERRALL,
Sub-Committee.

The effective work done by this Committee during the past year is indicative of the possibilities for the future.

A great deal has been said regarding publicity for the Society. As long as the publicity is for the purpose of putting the Society to the front, there is little accomplishment; but when the Society or its Committes do instructive work for the benefit of the community, then the Society will get publicity as is evidenced by comment in recent papers.

IMPORTANT

Engineering societies and other organizations will soon be making up their Fall and Winter programs.

The Western Society Auditorium, located on the seventeenth floor of the Monadnock Block, Chicago, is available for outside meetings, which do not conflict with the Society's program. It has a seating capacity of over two hundred and is equipped with a moving picture machine and projector lantern.

Rates and dates available may be obtained on application at the Secretary's office.

Society Policy Publication

The Board of Direction adopted at its meeting held June 20, 1921, the following resolutions:

"The Board of Direction disapproves the action of any member in giving interviews to newspapers or other publications involving the policy of the Society, without due authority."

An article in the Chicago Daily News of June 17, 1921, indicated, as definite, policies which have not been considered or adopted by the Board of Direction, nor formally considered by any of its committees.

THOMAS G. GAGE

Thomas G. Gage, M. W. S. E., died Sunday, May 23, 1921. Mr. Gage was head of the Thomas G. Gage Company, general contractors and builders. He became a member of the Western Society of Engineers March 12, 1920, and his death marked the passing of a good friend and conscientious worker.

W. S. CADWELL

Walter S. Cadwell, M. W. S. E., died February 5, 1921. He was elected a member of the Western Society of Engineers, November 5, 1912, and was at the time of his death Chief Engineer of the Senn High School, Chicago.

R. W. SUMMERVILLE

R. W. Summerville, M. W. S. E., died May 9, 1921, after a long illness. Mr. Summerville was employed by the Illinois Steel Company and was elected a member of the Western Society of Engineers December 26, 1919.

J. C. PORTER

J. C. Porter, M. W. S. E., died June 6, 1921, at the Illinois Central Hospital. At the time of his death Mr. Porter was Assistant Engineer, Illinois Central Railroad, Chicago. For the past seven years he had been connected with the same road in the Maintenance of Way Department. He became a member of the Western Society of Engineers May 7, 1920.

DANIEL W. MAHER

Daniel W. Maher, A. W. S. E., died June 20, 1921, as a result of injuries received in a construction accident while on business at Waukesha, Wisconsin.

Mr. Maher was secretary of the Marquette Construction Company, and was elected an associate member of the Western Society of Engineers June 5, 1889.

ENGINEERING EMPLOYMENT

We wish to assist in placing valuable men in the employment most suited to them. Many concerns have positions open now or will have in the near future. What could be more logical than an engineering employer obtaining assistance from an engineering society, or an engineer looking for a position to seek a source that is in close tough with the engineering profession? You can co-operate by communicating with the Secretary's Office.

POSITIONS WANTED

B-950: POSITION WANTED IN RAILROAD, Industrial or Highway Work. Experience, 17 years drafting, estimating, field and supervision, including resident and division engineer. What have you to offer?

B-949: POSITION WANTED BY GRADUATE C. E. having 20 years' experience office and outside work in roadway, construction, bridges, buildings, land valuations and contracts.

B-948: POSITION WANTED AS DESIGNER or production superintendent. Experience, 12 years in mechanical an d electrical fields. Would like to make connection where there is field for improvement of products or methods and developing new machines.

B-947: POSITION WANTED IN DRAFTING or tracing by young woman with three years' experience.

B-946: POSITION WANTED AS DRAFTSMAN on mechanical drawings and details—Civil, Electrical, Mechanical and Construction work. Also design and detail sof electrical apparatus

B-945: POSITION WANTED AS ARCHITECTURAL draftsman or superintendent on building work. Experience, 18 years.

B-944: POSITION WANTED AS SALES ENgineer, advertising or estimates on mechanical equipment or building products. Experience, 7 years.

B-943: EXTRA WORK SATURDAY AFTERnoons and evenings, preferably to take home. Drawing and drafting, computing, designing, surveys. Map drafting, track layouts, structural detailing, checking. Experience, 10 years.

B-942: POSITION WANTED AS DESIGNER of steel structures, checker or squad foreman. Experience, 16 years. Prefer work in Chicago.

B-941: POSITION WANTED AS CONSTRUCTION inspector in Chicago.

B-940: POSITION WANTED AS CONSULTING or supervising engineer with Chicago concern. Prefer office work.

B-939: POSITION WANTED AS ENGINEER or superintendent on construction, maintenance, operation, or track elevation preferred. Experience, 6 years.

B-938: POSITION WANTED AS MECHANICAL draftsman on piping. Experience, 10 years as draftsman, designer, detailer and checker.

B-937: POSITION WANTED IN MECHANICAL of electrical engineering, plant evaluation or efficiency work. Nine years' experience.

B-936: POSITION WANTED—YOUNG MAN 21 years old. Experience, three years on heating and power plant equipment. Wishes work outdoors along mechanical lines.

B-935: POSITION WANTED AS STRUCTURAL designer. Familiar with concrete design. Experience in office and mill buildings, smelter structures, and theaters.

B-934: POSITION WANTED BY GRADUATE C. E. as superintendent of construction or on special investigations, making estimates and plans in connection with water and coaling stations.

B-933: POSITION WANTED AS WORKS maintenance engineer, office or sales engineer, mechanical. Can handle large ojbs as well as men and systems.

B-932: POSITION WANTED AS STRUCTURAL Engineer, field or office. Experience, 9 years.

B-931: POSITION WANTED IN DESIGNING, detailing, estimating steel and concrete, including coal tipples.

B-930: POSITION WANTER IN INDUSTRIAL engienering and management, illuminating engineering or electrical maintenance. Experience, 14 years as executive, electrical and mechanical engineer, drafting, accountant, statistician, designer, economist, plant construction an dopera-tion.

B-929: POSITION WANTED AS ASSISTANT to factory superintendent or superintendent of construction (power plant work), or sales engineer, mechanical. Experience, 8 years in above work.

B-928: POSITION WANTED AS INSTRUMENTMAN or draftsman. Experience on R. R. track elevation work and valuation, drafting and designing on concrete work and concrete products plant.

B-927: POSITION WANTED AS ASSISTANT to vice-president, assistant to consulting engineer or sales engineer by gradaute M. E. Experience on inspection and building, also sales engineer, steam specialties for power plants.

B-926: POSITION WANTED AS SALES ENgineer in hosting machinery or heavy contractors' equipment. Five years' selling experience.

B-951: POSITION WANTED AS ENGINEER on concrete construction or sales engineer, railway equipment or supplies. Graduate engineer, 14 years' experience on railway construction, maintenance and water supply.

Engineering Employment, Continued

POSITIONS WANTED

B-980: POSITION WANTED AS PRODUCTION, Industrial or Sales Engineer by graduate M. E. Armour, 1916. Experience four years, covering broad mechanical field.

B-979: POSITION WANTED IN SALES OR Office Work by graduate M. E. Michigan, 1900. Thirteen years in one position.

B-978: POSITION WANTED IN ELECTRO-metallurgical plant using electric furnaces, or in small manufacturing plant where mechanical electrical experience can be utilized.

B-977: POSITION WANTED BY GRADUATE Electrical Engineer, Armour 1917, as equipment engineer or any position leading up to engineering sales.

B-976: POSITION WANTED IN THE ELECtrical field, Chicago or vicinity, by student who will be available during June, July and August.

B-975: POSITION WANTED IN MECHANICAL and electrical executive position or testing. Would consider technical writing or general literary work. Experience includes assistant professorship in steam engineering.

B-974: POSITION WANTER IN POWER plant design or assistant to consulting engineer. Experience three years as above.

B-973: POSITION WANTED AS DRAFTSMAN, mechanical or electrical. Seven years experience including electrical operating work.

B-972: POSITION WANTED AS STRUCTUral draftsman. Experience five years.

B-971: POSITION WANTED IN INSPECTION, supervision and reports on public utility properties or industrial plants. Principally mechanical engineering with possibility of application of electriacl. Experience broad, including five years consulting.

B-970: POSITION WANTER AS MECHANIcal draftsman or tracer. Experience six years.

B-969: POSITION WANTED AS CHIEF draftsman, designer, superintendent or estimator. Experience fourteen years including reinforced concrete, flat slab, structural steel and wood.

B-968: POSITION WANTED AS SURVEYOR or outdoor work.

B-967: POSITION WANTED DURING SUMmer in electrical drafting or testing.

B-966: POSITION WANTED AS DRAFTSMAN on special work and machinery during July and August. Experience six years. At present instructor mechanical engineering.

B-965: POSITION WANTED AS CONSTRUCtion engineer, assistant city engineer, or outside civil engineering work. Experience four years. Sewers, waterworks and on general construction.

B-964: POSITION WANTED AS COMBUSTION maintenance or power engineer. Experience twelve years.

B-963: POSITION WANTED AS CHIEF, OPerating or maintenance, ice plant construction or operation, also electrical construction work. Experience sixteen years.

B-962: POSITION WANTED AS MECHANICAL draftsman, detailer or letterer. Experience in heating, plumbing, power plants and conveyors, foundries.

B-961: POSITION WANTED BY CIVIL ENGIneer at present employed by large railroad. Wishes to locate in Chicago or vicinity account wife's ill health.

B-960: POSITION WANTED AS REFRIGERAtion Engineer, executive in manufacturing plant or maintenance engineer in power plant.

B-959: POSITION WANTED AS DISTRICT highway engineer, superintendent on sewers, water, or municipal work. Experience twenty years as engineer in charge of construction, sewers, waters and paving work.

B-958: POSITION WANTED IN BUILDING design or ocnstruction by graduate architectural engineering course. At present employed away from Chicago but is looking for a lccal connection.

B-957: POSITION WANTED WITH CONSULTing engineer on municipal, water supply, sewage treatment or hydro-electric development work. Experience seven years in above fields.

B-956: POSITION WANTED AS MECHANICAL engineer or designer on bascule bridges, power plants, waste dispcsal plants and in general engineering work.

B-955: POSITION WANTED AS SUPERINtendent of construction, architectural or structural draftsman. Experience seven years.

B-954: POSITION WANTED AS ENGINEERing executive, or sales engineering, in good line or can invest with services in engineering company, architect or manufacturing concern.

B-953: POSITION WANTED IN HEATING, ventilating ,plumbing or electrical work. Experience also in mechanical equipment.

B-952: POSITION WANTED AS STRUCTUral designer, concrete or steel. Experience six years. Graduate Armour C. E., 1915.

B-982: POSITION WANTED BY GRADUATE Mechanical Engineer, with experience as draftsman, designer, erection, production, maintenance and sale sengineer in executive capacity or sales engineering.

Engineering Employment, Continued

B-1016: POSITION WANTED AS STRUCTURAL designer, building superintendent or estimator by engineer having wide experience in railroad and building construction.

B-1015: POSITION WANTED IN POWER House or Radio work. Experience in above fields.

B-1014: POSITION WANTED AS STRUCTURAL designer or structural detailer by University of Illinois graduate, 1916.

B-1913: POSITION WANTED IN OR AROUND Chicago as assistant to municipal engineer, draftsman on municipal work or transitman on channel improvements or reclamation survey.

B-1012: ENERGETIC ENGINEER, UNIVERSITY of Michigan graduate, desires to connect with engineering or manufacturing firm which may in the future be interested in development of sales of machinery or engineering project in Poland or Russia. Eight years' experience railroad construction, manufacturing and sales with leading U. S. A. concerns.

B-1011: POSITION WANTER FOR SUMMER only in mechanical drafting or shop work.

B-1010: POSITION WANTED IN CONCRETE design or assistant on concrete construction by graduate Purdue, 1921, having experience as chief of party on road survey.

B-1009: POSITION WANTED BY YUNIVERSITY student in electrical engineering course. Prefers connection which will give him practical experience. Summer months only.

B-1008: POSITION WANTED IN DESIGN OF bridges or buildings by graduate Armour, 1921.

B-1007: EXECUTIVE WITH EXPERIENCE IN management corporations and consulting engineers who understands office routine, accounting purchasing, employment, visiting and directing field work, negotiating contracts and compiling engineering reports open for engagement.

B-1006: GRADUATE ELECTRICAL ENGINEER open for connection with good concern.

B-1004: WANTED POSITION AS DRAFTSMAN or tracer. Two years at Lane Technical High School.

B-1003: POSITION WANTED AS ASSISTANT engineer, manager of small plant or testing work on electrical apparatus. Willing to begin as apprentice.

B-1002: POSITION WANTED IN RAILROAD valuation or construction work. Familiar with making expert investigations.

B-1001: POSITION WANTED AS DESIGNER of dies, jig or tool work or on automatic stokers.

B-1000: WANTED, TEMPORARY POSITION for summer only; railroad or industrial work.

B-999: POSITION WANTED IN RAILROAD valuation; experience seven years.

B-998: GRADUATE ENGINEER AND LAWYER wishes to connect with responsible company as engineer assistant to valuation counsel. Also would consider position as valuation engineer or engineer on construction.

B-997: POSITION WANTED IN SURVEYING or outdoor work.

B-996: POSITION WANTED AS GENERAL manager, works manager, or superintendent in research or development work along metal manufacturing lines.

B-995: MECHANICAL ENGINEER WITH EXPERIENCE on oil burning furnaces or allied industrial engineering problems; six years; open for engagement.

B-994: POSITION WANTED FOR SUMMER only in engineering office.

B-993: POSITION WANTED WITH CONSULTING engineering firm who specialize in power plant work.

JOB 2851—West. Soc. Engineers—Galley 19—

B-992: POSITION WANTED AS INSTRUMENT man or rodman, with railroad experience.

B-991: POSITION WANTED AS SURVEYOR, steel designer or concrete inspector; experience two years.

B-990: POSITION WANTED IN MECHANICAL designing; tools, jigs, and fixtures, machine shop efficiency, or time study. Experience six years.

B-989: POSITION WANTED IN ELECTRIFICATION of railroads, power plant work or railway purchasing, by graduate Massachusetts Institute Technology, 1914.

B-988: POSITION WANTED IN CHECKING or detailing structural steel. Experience five years.

B-987: POSITION WANTED IN STRUCTURAL or railroad engineering field by graduate Armour, 1919.

B-986: POSITION WANTED AS CONCRETE wood or steel engineer. Can take full charge of mill building.

B-985: POSITION WANTED AS INSTRUMENT man or rodman, on highway work.

B-984: CHIEF ENGINEER WHO HAS HAD charge of operation and maintenance of central station and industrial steam-electric power plants open for engagement. Experience twenty years. Good knowledge of boilers, stokers, turbines, condensors, feed water heaters, pumps, compressors and refrigerating systems.

B-983: POSITION WANTED IN POWER plant work, or engineering sales.

B-1018: POSITION WANTED AS CHIEF ENgineer, Chief Draftsman, Office Engineer, Sales or Contracting Engineer by engineer with fourteen years experience in steel, concrete and heavy machinery.

JOURNAL OF THE
WESTERN SOCIETY of ENGINEERS

Volume XXVI AUGUST, 1921 Number 8

NEWS OF THE SECTIONS

JUNE MEETING

No. 1137 **June 20, 1921**

On Monday evening, June 20, 1921, a joint meeting of the Mechanical Engineering Section of the Western Society of Engineers was held with the Chicago Section, American Institute of Electrical Engineers, and the Chicago Section, American Society of Mechanical Engineers.

The subject of the evening was an illustrated lecture entitled "The Motion Picture's Secret Part in Winning the War," by Mr. John F. Strickler, M. W. S. E., Western Manager, Picture Service Corporation, Chicago.

Several reels of film were shown giving the audience an insight into the workings of the gas engine, rifle grenade, depth bomb, and starter motor for automobiles. Interspersed with these pictures were some reels of comedy and motion picture pencil sketches.

Mr. Strickler's remarks, which follow, will give the reader a further thought along motion picture lines.

The Department of Labor announces its opinion that the motion picture shortened the war by at least two months. Most of us are familiar with the public use of the cinema by the Agricultural Department, by the Committee on Public Information ,and in the Liberty Loan drives. But now that the curtain of censorship has been lifted, it is permitted to reveal to the American business man the strides that have been made privately in the motion picture as a means of instruction and demonstration, under the stimulus of the army's demand.

Most of us have known the motion picture merely as a toy, as a means of amusement; and it has no more than occasionally occurred to us how effectively it might be used as a medium of instruction, aided by lightning lucidity to the least intelligent, conclusive and convincing to the intellect, as well as powerful in emotional appeal.

The fact is before us to be recognized, that the motion picture is a new means of mass communication, far greater in its scope than the printing press, for words are artificial and require learning, while pictures have universal meaning, to child and savage and savant alike. That seeing is believing is an adage. "I see" is synonymous with "I understand." When Edison invented the cinematograph, the tangle dating from Babel was undone.

But it is not merely illiteracy and the confusion of languages that we brush aside with the motion picture; we also fill deficiencies in vision; so that the least perceptive minds and the blankest brained come before the screen on a level, in many respects, with the most imaginative.

As all know, this war has been largely a war of machinery, with its ultimate ideal a flame projector or rapid firer in almost every fighter's hand. Depth bombs, steam shovels, and the machine guns must be understood and operated almost in myriads. So the need for men was too great to be supplied by mechanical geniuses alone. When the draft contingents came to the camps and colleges, the gov-

ernment faced the task of making competent operatives out of the rawest material. Complex mechanisms,—costly,—must be comprehended and used effectively, by recruits like the lone mountaineers of Kentucky and the herders of Wyoming, men who never had handled any appliance more complicated than a wagon wheel, a boat's oar or a spade.

At that time, one of the inventors of the animated cartoons, J. R. Bray, was experimenting with motion pictured mechanical drawings. He had already obtained patents on processes which made it possible to put draftsman's sketches in movement and was beginning to market such pictures for the instruction of salesmen and for use in industrial schools. Later than we could have wished, it occurred to him to suggest their use by the government. Immediately the facilities of his studios were taken over for the service of the army. Technical experts of his staff were placed in charge of the work. Films were made of some of the simpler mechanisms and the results were so gratifying to the officers detailed that plans were quickly made on a broad scale.

Very soon a student group in an officers' training camp was taken into a hall equipped for projection, to be shown "moving x-rays" of the hand grenade, the operating interior of the machine gun and cross sections of cannon in the act of firing.

From that time on, steps were swift. Finally the rapid exposition, uniformly intelligible, of the most complex electrical mechanisms, was achieved, including picturizations of many things never before seen except in the mind's eye. In the farthest present development these pictures begin with an ordinary exterior and changes into a skeleton cross-section. One unit at a time is built up. Each part is shown separately, first still and then in operation. Any part unneeded for a moment is eliminated, to be brought back when again to be permitted attention. Each part functions independently or in association. Photographic reality alternates on the screen with the technical drawings, one fades into the other. Electrical forces are visualized for the unimaginative. Explosions are delayed until they are viewed as a progression, seen through the open side of the gun.

All standard possible faults of operation were exposed, and their results, however dire, shown plainly and repeatedly without danger. One filmed, disaster and destruction were repeatedly produced within a hall, without preparation, without expense, without damage. Darkness except on the screen excluded all distraction. Subjects were displayed and removed from the canvas at will. There was no difficulty of crowding or cranning. Everybody could see what was being exhibited; no one could see anything else.

By such means it takes little time to turn raw recruits into expert operators of the most expensive and delicate machines of modern warfare. Before intricate instruments are touched, they are perfectly understood in theory. Men of simple minds and small vocabularies and many languages come immediately to "see how it works." From that point it is a short step to the proficiency that comes with manual familiarity. Many who are lost by the spoken lecture can spell out a few words at a time on the screen. And the visual impression is lasting. "The eye remembers while the ear forgets."

The motion picture industry, fifth largest in the United States, does not wish to be considered only as an entertainer for leisure hours. It wants to be recognized as an industrial utility, eager for usefulness in all fields of life, ready to add to human effectiveness as well as to human happiness. It is at the service in peace and reconstruction.

COMMITTEE PROGRESS REPORTS

Committee Assignment

A Committee on Committees has been authorized by the Board of Direction and they are at the present time actively engaged in assigning members to the various committees of the society. The report of this committee will be included in the September Journal.

Especial attention is called to the Applied Technical Committees of the Society as an opportunity for the members to engage in special studies of engineering matters outside of their regular engineering specialty. Each of these committees will have a small Executive Committee who will do the planning for the study. The membership of the committee, however, is not limited to this Executive Committee, but is open to all members of the Society who are interested in a study of the subject before the committees.

These Applied Technical Committees are as follows:

- Waterways Committee
- Terminals Committee
- Aviation Committee
- Research Co-operation Committee
- Building Committee.

I would also consider with these the
- Public Affairs Committee.
- Young Men's Forum.

The Secretary will be very glad to receive word from the members as to the Committee that they would be interested in working with during the coming year. These responses are requested at as early a date as possible so the work of the Committees can be organized without further delay.

These Committees are not confined to particular technical specialties, such as are indicated by the terms, Civil Engineer, Electrical Engineer or Mechanical Engineer, but involves various kinds of engineers, architects as are interested in the operation of utilities and industries.

The Waterways Committee will continue a study of the possibilities of developing inland waterways, especially as they relate to Chicago. The development of the Illinois River Canal project is now moving rapidly towards completion and its relation to inland transportation will be considered by this Committee. The St. Lawrence-Great Lakes Waterway is now occupying considerable attention and a detailed study of the possibilities of this large project and its relation to Chicago, as the mid-west gateway, will be part of the work of this Committee.

The Terminals Committee will continue its study during the coming year of the terminal situation in Chicago. Probably no one thing is so important to the economical development of this city as the development of proper plans for railway terminals, which at the present time are complicated and, in many instances, are duplicated far beyond necessity.

The Aviation Committee will consider the future possibilities of commercial aviation, a subject which has a large opportunity for those who are interested in this new development of engineering work.

The Committee on Research Co-operation is newly organized and the object of this Committee is to study as far as possible methods of increasing the use of research in the development of the engineering work and the industries. Professor Millikan's address at the Annual Dinner was an outline of the work undertaken by the National Research Council. There is a great opportunity for the members of the Western Society of Engineers, recognizing research as being the basis of future progress of the profession, who will join in this study of research methods and possibilities.

The Committee on Building is a new departure for the Society. The object of this Committee is to study the building as a utility, rather than a structure. The scope of the Committee will include not only dwelling houses, apartments and industrial buildings, but office buildings as well. The interest of engineers and architects in building construction has largely terminated with the completion of the building and the first occupancy. Further occupancy and use of this building will develop, if studied carefully, many opportunities for better construction and better planning. This Committee is open to architects, engineers—both structural, foundation,

mechanical, electrical—and also those men in the Society who are interested in the maintenance and operation of buildings used by the industries and by the public. There will be opportunity for a study of the building codes of this city and of the other large cities of the country, to the end that recommendations may be made which will greatly benefit the public and improve the building and housing conditions of our large city.

The Public Affairs Committee will continue a study of those matters of civic interest, which are based upon engineering experience and investigation. The Committee during the last year had active membership of approximately forty and held their meetings weekly at lunch, at which time the matters of interest were discussed by the committee and many reports made. It is earnestly desired that all of our members who are interested in the extension of the influence of the engineer in public affairs, will avail himself of the opportunities of joining this committee and assisting in its important work.

The Young Men's Forum is a development which has met with considerable success in the Society. It is not necessarily confined to those who are young in years, but those who wish to get together and consider matters which are not strictly engineering, but have to do with the engineer in his business relations and his progress in society as a whole. Meetings will be held Saturday afternoons in the Society rooms and addresses by prominent educators, business administrators, bankers and other public spirited men, who are interested in the advancement of young men in their professional life. Those who have attended the meetings in the past will be interested in the opportunities for the new year and are urgently requested to be recognized as members of the Young Men's Forum by indicating their preference to the Secretary.

The Committees of the Society are the active life of the Society. It is planned during the coming year that the number working on committees will be greatly increased over previous years and the hearty response which is being received from all who have been asked to serve on committees, is indicative of the splendid desire of our members to be active in these things. Recognition of the profession will follow when the members of the profession show their desire to enter into public life and to render public and civic service.

EDGAR S. NETHERCUT,
Secretary.

PERSONAL NOTES

Announcement is made of the appointment of Bernard J. Fallon, M. W. S. E., as General Manager, Chicago Elevated Railways. Mr. Fallon is widely known in the electric railway field and his recent promotion came after fourteen years' service with the Elevated Railways, where he began in 1907 as engineer, Maintenance of Way, for the Metropolitan West Side Elevated Railroad. In 1909 he was made Assistant General Manager of the same company and when the Elevated Lines of Chicago were consolidated in 1911, Mr. Fallon became engineer, Maintenance of Way with jurisdiction of the combined properties.

Mr. Fallon's first railroad experience was with the Chicago, Burlington & Quincy Railroad in 1898. Starting as rodman he held the position of Assistant Engineer, Division Engineer and later Engineer of Track Elevation in Chicago.

In addition to being a member of the Western Society of Engineers, Mr. Fallon is a member and director of the Chicago Engineers' Club and a member of the American Electric Railway Engineering Association.

Col. Herbert S. Crocker has reopened his office as Consulting Engineer at 207 Tramway Building, Denver, Colorado. Col. Crocker resumes after a period of three years his former practice. During this time his service in the Construction Division of the army as colonel in charge of the Brooklyn Terminal, has been very successfully carried on. During the last year and a half Col. Crocker has been Acting Secretary of the American Society of Civil Engineers.

Mr. Chas. H. MacDowell, President, Western Society of Engineers, has been honored by re-election to the presidency of the National Fertilizer Association at their recent meeting at White Sulphur Springs. This is Mr. MacDowell's fourth term as President, he having been President in 1903 and 1904 and again in 1920.

F. E. Wertheim, M. W. S. E., Mechanical Engineer, Liquid Carbonic Company, Chicago, has resigned his position with that company to enter the service of the Peoples Gas, Light and Coke Company.

Mr. Charles Clarahan, Jr., junior member, W. S. E., has moved to Little Rock, Arkansas, and taken a position as Structural Engineer with N. B. Garner. Mr. Clarahan's address is 336 Gazette Building, Little Rock, Arkansas.

Ernest V. Lippe, M. W. S. E., Consulting Mechanical Engineer, has established an office at 108 South LaSalle street, where he will continue his engineering practice. Mr. Lippe was formerly located in the Kimball Building.

J. A. Scanlan, A. W. S. E., has resigned his position with the Paul J. Kalman Company, Chicago, to accept employment with Victor C. Carlson, 701 Church street, Evanston, Ill., as structural engineer.

M. M. Fowler, M. W. S. E., attended the A. I. E. E. meeting at Salt Lake City in June. Before returning to Chicago he stopped at Santa Fe, New Mexico.

W. G. Arn, M. W. S. E., has been appointed Chairman of the Railway Engineering Section.

A. B. Gates, M. W. S. E., has returned from Lake Mills, Wisconsin, where he was spending a vacation with his family.

H. B. Kirkland, M. W. S. E., President of the Concrete Mixing and Placing Company, announces the removal of their offices from 123 West Madison street to Room 802, Great Northern Building, Chicago.

Grover Keeth, M. W. S. E., mechanical engineer, Victor Chemical Works, Chicago Heights, has resigned from that company to accept a position with the U. S. Gypsum Company.

Brig. Gen. George H. Harries, M. W. S. E., Commanding General A. E. F. Base Section, No. 5, at Brest, France, and after the armistice, head of the Allied Commission in charge of prisoners of war in Germany, has been decorated with the Order of Leopold by the Belgian Ambassador, Baron de Cartier, in recognition of his services in behalf of the Belgian prisoners. The ceremony took place July 22, at the Belgian embassy, Washington, D. C., in the presence of officers of the American and Belgian armies.

FROM THE SECRETARY'S OFFICE

Edgar S. Nethercut, Secretary

RECOGNIZATION

The following editorial appeared in the Chicago Daily News of June 29, 1921:

CREDIT WHERE CREDIT IS DUE.

Thoughtful and independent members of the legislature are in position to estimate correctly the value of the services performed during the recent session by the civic organization of Chicago and the rest of the state. But the average citizen hardly realizes the extent of the debt he owes to these organizations, supported by voluntary contributions and often maligned and slandered by the designing spoilsmen, whose best laid plans of graft and grab are exposed and not infrequently defeated by timely investigations and convincting reports.

The Chicago Bureau of Public Efficiency, the Chicago Citizens' Association, the Legislative Voters' League of Illinois, the Civic Federation, the Chicago City Club, the Western Society of Engineers, the Woman's City Club and other such public-spirited organizations deserve commendation and gratitude for their earnest and effective work during the legislative session in watching the proceedings, analyzing bills, challenging misleading statements or statistics, and calling attention to objectionable or dangerous provisions in pending measures.

To this vigilant service Illinois is indebted for the defeat of several particularly vicious bills. For example, the Wheeler bill, which would have wrecked the civil service of the state and restored the old spoils system in all its offensiveness, was fought with special vigor and efficiency by the Legislative Voters' League. Its bulletins made a deep impression on legislators, who might otherwise have been misled by the false pretenses of the spoils machine.

More power to these admirable civic organizations!

In the above editorial the Western Society of Engineers is recognized as a civic body. It is with credit we are accorded a place with the other civic societies listed in this editorial. While we are inclined to call ourselves a professional society, yet it is as we recognize opportunity for civic duty and encourage our members to participate in civic matters, that we will have a stronger position before the public of Chicago and environments. The Western Society of Engineers has entered into discussions and made reports on matters pending before the legislature where our opinions have been favorable to pending legislation and in that respect we possibly can be recognized as doing constructive work. It should not be considered, however, that opposition to proposed measures is not constructive. In many instances the most constructive position that we can take, is opposing those things, which, in our judgment and our experience as engineers, we believe are adverse to public interest.

The Public Affairs Committee of our Society has done excellent work during the last year. It has been and should be commended by our membership. It is greatly desired that more of our members shall enter into the affairs of the Public Affairs Committee. This will redound to the benefit of all. In planning for the active year of the Society, which begins in September, there will be a splendid opportunity for our members to indicate their wish to meet with the Public Affairs Committee at its regular weekly meeting.

The legislature has adjourned and unless a special session is called, will not be in session for two years. The Board of Aldermen and the Trustees of the Sanitary District will be busy during the coming year and before them will come very many constructive measures, which have as their basis, engineering experience and knowledge. These measures are fraught with great possibilities for benefit to the citizens; also it is safe to say that grave danger may be introduced if the acts of the municipalities are not well founded upon economic theories and practice. A helpful relation should be established with all the government bodies in our city, so that we will have an opportunity of constructive criticism and using the position which we now occupy, and by publicity assist in molding public opinion. More power will be given to these civic organizations in proportion as they use the power which they now have.

Revision of Building Codes

Mr. Herbert Hoover, Secretary of the Department of Commerce, has recognized the necessity of a revision of the Building Codes of the various cities. Realizing the value of the Engineers Society in carrying out this work the following letter has been received:

Department of Commerce,
Office of the Secretary.

Washington, June 8, 1921.

Mr. Edgar S. Nethercut, Sec'y.,
Western Society of Engineers,
1735 Monadnock Block,
Chicago, Ill.

Dear Sir:—I have recently appointed a committee to define some of the needless variations and disagreements in building codes, and to suggest amendments. The names of the members of the Committee and their associations are given on the sheet enclosed.

The interest of your organization in this general subject, and its contact with construction problems, lead me to ask if you could arrange for one of the members of your organization to be appointed to co-operate from time to time with this Committee.

At the outset it would be helpful if such a representative of your organization would gather any data upon this subject that may have been compiled by any of your committes and would forward it for the use of the Building Code Committee, care of the Department of Commerce.

Regarding this work as of special importance at this time, I will be very grateful for your co-operation.

Yours faithfully,
HERBERT HOOVER.

MEMBERSHIP OF THE DEPARTMENT OF COMMERCE BUILDING CODE COMMITTEE.

Edwin H. Brown, Architect, Minneapolis, Minn., Chairman, Committee on Small Houses, American Institute of Architects.

William K. Hatt, Professor of Civil Engineering, Purdue University, Lafayette, Ind., Specialist on Structural Materials.

Rudolph P. Miller, Superintendent of Buildings, New York City, Chairman, Building Officials' Conference.

J. A. Newlin, in charge of Timber Tests, U. S. Forest Products Laboratories, Madison, Wis.

Ernest J. Russell, Architect, St. Louis Mo., well-known authority upon building construction.

Joseph R. Worcester, Consulting Engineer, Boston, Mass., specialist on structural steel construction.

Ira H. Woolson, Chairman, Consulting Engineer, National Board of Fire Underwriters, New York City.

The Western Society of Engineers is greatly interested in the constructive move by Mr. Hoover. We will co-operate fully.

Chicago Zoning Association

Believing that the best interest of Zoning and City Planning can be greatly advanced by organized effort, there has been organized in Chicago an association consisting of representation of various civic and professional societies.

The object of this Association is:

(a) To co-ordinate and to stimulate in the best development of Zoning in the City of Chicago; to act as a clearing house for ideas and activities on the subject, gathering material and distributing it to the members; to promote public information and interest in Zoning.

(b) To co-operate with the city authorities and with the Zoning Commission, when appointed, in furthering the best interests of Zoning.

It is intended to include as fully as possible all Societies and Clubs in Chicago, whose purpose and policy is to advance this great benefit to our city.

The charter members of this Association are:

American Association of Engineers, Chicago Chapter.

American Institute of Architects, Illinois chapter.

Building Managers' Association.

Chicago Woman's Aid.

Chicago Woman's Club.

Citizens' Association.

City Club of Chicago.

Cook County Real Estate Board.

Illinois Society of Architects.

Municipal Art League.

Western Society of Engineers.

Woman's City Club of Chicago.

In organizing this Association, Chicago has been influenced by the very successful work of a similar Association in New York.

The Western Society of Engineers has through its Public Affairs Committee had considerable influence in promoting Zoning. Through this new organization there is greater opportunities.

The officers of the Association are:

Chairman—Charles Herrick Hammond.

Vice-Chairman—Joseph K. Brittain.

Secretary-Treasurer—Edgar S. Nethercut.

Additional members of the Executive Committee are: Everett L. Millard, George O. Fairweather, C. T. B. Goodspeed, Miss Julia B. Stern, Miss Grace C. Temple, Miss Madge Headley.

The headquarters of the Association are at the Western Society of Engineers.

The Kansas City Star of July 10 announces the appointment of a Non-partisan Water Board for the City of Kansas City. This board consists of four citizens. The Chairman of the Board is Mr. Alexander Maitland, Civil Engineer of many years' practice at Kansas City and now President of the Kansas City Bridge Company.

The appointment of a non-partisan board with an engineer as chairman presupposes the successful completion of a water supply project for Kansas City, which will total in the neighborhood of $11,000,000. Two members of the Board serve for eight years from April, 1922, and two members for six years from the same date. The project is now to be submitted to the citizens of Kansas City for vote at the next election.

A. S. M. E., Spring Meeting

The date of the American Society of Mechanical Engineers' spring meeting to be held in Atlanta, Georgia, in 1922, has been set for May 8th through May 11th.

JOHN F. WALLACE

John Findley Wallace, M. W. S. E., died at Washington, D. C., July 3, 1921. The news of his death was a great shock to the engineering fraternity by whom he was greatly beloved.

Mr. Wallace was born at Fall River, Massachusetts, September 10, 1852, and when a young man moved with his parents to Monmouth, Illinois. He was graduated from Monmouth College in 1871 and afterward became U. S. Assistant Engineer on the Mississippi River improvements.

In 1879 Mr. Wallace was made Chief Engineer, and later Superintendent of the Burlington, Monmouth & Illinois Railroad. In 1886, as assistant engineer for the Union Pacific Railway, he had charge of surveys in the Rocky Mountains and the next year was appointed bridge engineer of the Santa Fe Railroad, under Octave Chanute, consulting engineer of the Company.

In 1891 Mr. Wallace was engaged by the Illinois Central Railroad, and his time was devoted largely to the transportation problems in connection with the World's Fair and to the general improvement of the railway company's Chicago terminals. In 1892 he was appointed Chief Engineer of the Illinois Central. In 1898 he became Assistant Second Vice-President, in 1901 Assistant General Manager and later General Manager.

Mr. Wallace was chosen Chief Engineer of the Isthmian Canal Commission in 1904. In 1905 he was appointed consulting engineer on the Chicago terminal of the Chicago & Northwestern Railway.

In 1906, he was elected President of Westinghouse, Church, Kerr & Company, New York.

For the past five years, Mr. Wallace maintained an office in New York City as Consulting Engineer. He was also Chairman of the Chicago Railway Terminal Commission.

Besides being a Past President of the Western Society of Engineers, Mr. Wallace was also a Past President of the American Society of Civil Engineers, and the American Railway Engineering Association.

At the time of his death, Mr. Wallace was attending hearings of the Senate Committee on Interstate Commerce.

GEORGE H. TEFFT

George H. Tefft, Aff. W. S. E., for some time connected with the Clay Products Association, Chicago, died at Philadelphia. Mr. Tefft had gone to Asbury Park, New Jersey, to attend the meeting of the American Society for Testing Materials. He had not been well for some time prior to then, but his condition necessitated his being removed to the Orthopedic Hospital, Philadelphia, where he died July 7, 1921. He was buried at Springfield, Missouri, his old home. His wife and a sister survive him.

C. W. PIFER

Charles W. Pifer, M. W. S. E., died April 21, 1921, at Clinton, Illinois. Mr. Pifer was office engineer, U. S. R. R. Administration, in Chicago and became a member of the Western Society January 27, 1920. He leaves a widow, Mrs. Gertrude Pifer, of Clinton, Illinois.

The Foreman

The State of Michigan has a State Board of Control for Vocational Education with offices at Lansing. Mr. K. G. Smith, M. W. S. E., is supervisor of industrial education and a member of the executive staff of the board. He has made a very thorough study of industrial conditions throughout the state and has written, with the assistance of Mr. Thomas Diamond, the following article on "The Foreman," which will be of interest to our readers.

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Industrial education, as a branch of the larger field of vocational education, has come into considerable prominence during the past few years. This branch of education has for its aim the training of individuals along such lines as will raise them to their highest industrial efficiency, and at the same time make them more intelligent members of their community.

Our industrial experiences during the war brought home to us more emphatically than ever before the necessity for this training of workers, and as a result, the efforts of educational experts have been directed toward the problem of providing a type of education that will fit our industrial army for its job.

In their haste to get this work started those who have been responsible for it have confined their efforts to the training of the rank and file, with the result that, up to comparatively recently, the non-commissioned officers, or foremen, have been neglected. That they have been neglected has not been so much a matter of intent as it has been a lack of understanding of the psychology of the foreman. All of the excellent courses which have been provided in many of our cities are open to foremen, workers, and apprentices, on an equal footing, and many of them would undoubtedly benefit the foreman as much as they benefit the apprentice. Unfortunately the average foreman is averse to sitting in the same class with his men, and few of them are willing to admit before their men that they have many things to learn.

IMPORTANCE OF THE FOREMAN.

Another reason for the neglect is that it is only within the past three or four years that the strategic position held by the foreman has been appreciated, and that the possibilities for developing his usefulness have been realized. It has been discovered also that the attitude of the foreman, and his appreciation of the relation between production and cost, have a vital influence on what is accomplished in a factory. Not only is this true, but it has been noted that he is in constant touch with, and usually understands those workers who have been the cause of the recent disturbances in our industrial family. Because of this he is in a position to assist in the education of these workers to the point where they realize that their interests and the interests of their employer are identical and not antagonistic.

In order to aid the foreman in establishing the right viewpoint regarding production, and in order to prepare him for the task of educating his workers, it is necessary that he be given a vision of his job far beyond the limits usually established by precedent. It is necessary also that he be convinced of the wisdom and the justice of the thoughts he is trying to convey to the worker.

OPPORTUNITY FOR DISCUSSING SPECIAL PROBLEMS.

If a foreman is to broaden his vision regarding his job, if he is to crystalize his thoughts regarding the ideas which prevail among the workers, and if he is to co-operate to the fullest extent in transmitting the right slant on these ideas to the workers, it is necessary that some means be provided whereby he can meet with his fellows for the purpose of exchanging ideas, and for discussing those problems of foremanship which are of common interest.

During the past two years representatives of the Federal Government have done excellent work in planning methods and materials for bringing before the foreman his new responsibilities. In addition to this work several groups of foremen have been organized, either for the purpose of discussion or for the purpose of developing men to conduct the discussions in their plants or communities. Most of these have been organized by employers who are alive to the necessity for building up a strong intelligent group of foremen, al-

though a few, notably in Cincinnati, Cleveland, and Grand Rapids, have been started by the educational authorities in co-operation with employers.

THE FUNCTION OF THE TECHNICAL SCHOOL.

These efforts have merely touched the fringe of the problem and have served only as a means to stir up an interest in the potential value of the foreman as a leader of thought in industry as well as a director of operations. That a force commensurate with the opportunities for service be built up it will be necessary for our engineering colleges as well as for our technical and vocational schools to do their part in training leaders for industry who will go into it fully alive to the many questions which continually threaten the peace of our industrial life. In the past these institutions have done excellent work in preparing their graduates to meet the many technical difficulties which arise continually in modern industry. They have in many cases taught the skill and knowledge necessary to fashion the raw and semi-raw materials into marketable articles. In other words our schools have provided training in the technical processes and in the manipulative skill necessary in industry but have neglected to give their graduates the necessary understanding of *"How to get along with men"* and of the fundamental relations between capital and labor.

If our engineering colleges and technical schools as well as our vocational schools would make it a prerequisite for graduation that each candidate for a diploma take special courses in what we might call "Shop Economics" and "Shop Psychology' our embryo leaders would be spared the necessity of learning by bitter and costly experience that the path of the modern industrial leader is beset by undreamed of mind-disturbing problems. If this idea were adopted by our schools a majority of the foremen of the future might be expected to enter industry with a full understanding of their responsibilities and opportunities, but in the meantime, thousands of foremen are already on the job, and it is on them that we must concentrate our efforts for the purpose of helping them toward a new and broader conception of their duties.

THE FUNCTION OF THE ENGINEER.

To do this involves consistent effort on the part of every executive member of an organization. This is particularly true in regard to those who are charged with the engineering work in a factory. The engineer is responsible for the designing of equipment in many cases, in others he is entrusted with the movement of materials through the factory, or he is held responsible for the equipment being used to its fullest capacity. In whatever field he is employed he should make it a part of his job to study the human factor in industry, with the idea of determining the relative importance of management, materials, equipment, and men. As he will always be coming in contact with the foreman and will frequently have to work with him, he should use every effort—diplomatically—to sell the results of this study to him with the idea in mind of commanding his co-operation in every movement of the management to get a maximum production at a minimum cost.

There is a very large and entirely new field for study for the young engineer in this question of human relationship, and in the question of how the strategic importance of the foreman's position may be utilized to the utmost. There is pioneer work to be done, and there are endless possibilities for the good of industry. To do this work well requires not merely an engineer, it requires a man who knows his job thoroughly, who is willing to admit that a foreman may have something to contribute to any contemplated plan, and who is willing to use the contribution, who practices the golden rule, and who is big enough to admit it, even to a foreman if he has made a mistake. The average foreman is a normal being and responds readily to considerate treatment, let us therefore, in our work as engineers strive to give him credit for knowing his job well and to use that knowledge to the utmost in all our efforts to carry out the policies of the management or to raise the efficiency of our plant.

Federal Aid Roads Under Construction or Completed

The mileage of Federal aid roads which have been built or are now under construction is nearly sufficient to encircle the globe. This is the record of work accomplished since July, 1916, when the Federal Government first stepped in to aid in the enormous task of building highways that are now called upon to carry more than 9,000,000 motor vehicles plus a very substantial horse-drawn traffic in the forty-eight states. The Federal aid law is well named. The Department of Agriculture has given the broadest possible construction to the law for the purpose of providing the greatest mileage of highways suited to the traffic to be carried over them, at the minimum expense. An analysis by the Bureau of Public Roads of the projects under contract shows that all types of roads, from the graded earth road up to the finest paved surfaces, have been built.

HELP BUILD 22,030 MILES OF HIGHWAY.

On March 1 of this year, 22,030 miles of highway, extending into every state, had been completed or were in process of construction, says the bureau at a total cost which will be incurred for each type, and the mileage of each type, based upon the records of plans approved, are as follows:

PER CENT AND MILEAGE OF EACH TYPE ROAD.

	Per cent of Total Estimated Cost.	Mileage
Type 1, including earth, sand clay and gravel...........	32.2	15,300
Type 2, including water-bound and bituminous macadam..	9.0	1,530
Type 3, including brick, bituminous concrete, Portland cement concrete	48.8	4,890
Miscellaneous	4.0	310
Bridges	6.0	.....
	100.0	22,030

The states initiate the road projects, but before Federal aid is granted an engineer of the bureau makes an inspection of the roads to be improved, studies the local conditions, consults with the State Highway Department, and no projects are approved which are not considered suited to the conditions to be met. Many popular fallacies exist as to road improvement, and there have been many misconceptions as to the types of roads on which Federal aid funds may be used. Properly built earth roads, say specialists of the department, are the fundamental requirement in all highway improvement. Regardless of the material or type of surfacing which is to be placed, the preparation of the road bed requires the highest engineering skill and experience. The department considers that the use of adequate sums for the securing of proper location, thorough drainage, permanent bridges and culverts, and the elimination of railroad crossings is demanded if enduring improvements are to result.

Federal aid is allotted to the improvement of earth roads, but only with the stipulation that a suitable surfacing will be placed as soon as funds become available. This allows the road bed to be prepared and become thoroughly consolidated before the surfacing is placed, which is highly desirable from a construction viewpoint. To follow such a course, however, is out of the question when a road is heavily traveled and some form of surfacing must be provided. To care for traffic under these conditions, frequently a sand clay or gravel surfacing is provided, which will serve for several years and yet allow the road to be maintained under reasonably heavy traffic.

USE MANY KINDS OF ROAD SURFACE.

Granting that the preparation of the road bed has been properly done, many kinds of road surfaces will give excellent service. The element of time is important. There are so many miles of roads to be constructed, and their cost will be so enormous that the most careful and detailed study of each road project must be made to provide, at the lowest possible cost, roads which will give satisfactory service and which can be maintained without undue depreciation under the traffic which is to use them. Many times the question has been asked the bureau, What type of road is best? The answer is always the same: There is no one best kind or type of road surface.

A reecnt statement issued by the officials of the bureau expresses this thought in the following language:

"It is the policy of this bureau to consider the conditions on each individual Federal aid project, as there are elements such as subgrade, drainage and present and prospective traffic, which vitally affect the determination of the standards of construction to be used."

That is, there must be a careful analysis both of the engineering and economic conditions for each particular case to determine the kinds of materials that can be used successfully, and after these facts are determined then the various types of construction which can be used economically should be brought into competition to secure the best possible results. There have been occasional attempts to write into state laws or the governing conditions of bond issues a requirement as to the type or kind of roads to be constructed. To follow such a course would be most unfortunate.

The cost must always be considered in determining the type of road surfaces which are selected, and the allowable cost must be determined by the traffic which is to be borne. Local conditions vary to such an extent that very careful consideration must be given each project before determining the character or type of roads to be built. This principle was recently expressed to a Chamber of Commerce asking for information, in the following language:

"Types of highways should not be specified by law. This is a matter to be decided by the State Highway Department in which should be lodged full authority both to construct and to maintain. Competition between different types of materiail should be maintained and selection made to fit traffic requirements in each case. The bureau does not recommend any one type to exclusion of others."

ADDRESSES WANTED

In order to have our records of members' addresses complete, we ask that anyone knowing the present address of members listed below to communicate with the Secretary.

Name.	Last Address Given.
James L. Anning	Rice Hotel, Houston, Texas
H. S. Baker	6657 Greenview Ave., Chicago, Ill.
B. H. Bryant	Apartado 46, Chichuahua, Mexico
D. H. Cahn	1004 Powers Bldg., Chicago, Ill.
Harold Cohn	168 W. North Ave., Chicago
H. W. Deakman	Lieutenant, 311th Engineers
C. A. Erbach	Room 427, 140 S. Dearborn St., Chicago, Ill.
Henry Fox	B. & O. Railway, Clarksburg, W. Va.
W. Hess	4442 Dover St., Chicago, Ill.
H. F. Hill	Care of Chicago Telephone Co., Chicago, Ill.
Earl Hilton	5237 Ingleside Ave., Chicago, Ill.
Henry H. Hindshaw	Box 27, Hibbing, Minn.
Wm. B. Jackson	Room 1215, E. 123rd St., New York City, N. Y.
C. N. McNeil	1732 First National Bank Bldg., Chicago, Ill.
Miles H. Mann	Teetor Adding Machine Co., Des Moines, Ia.
Clarence E. Miller	Ohio Bell Telephone Co., Cleveland, Ohio
T. R. Minert	1606 Hewitt Ave., Chicago, Ill.
Samuel Moreèl, Jr.	4604 Vincennes Ave., Chicago
Vincent Pagliarulo	628 Grace St., Chicago, Ill.
Roger C. Palmer	U. S. S. M. A. Barracks I, Champaign, Ill.
Louis A. Pettibone	Fon Du Lac, Wisconsin
Jerre T. Richards	13323 Emily St., Chicago, Ill.
T. H. Robertson	Dawson Springs, Ky.
T. B. Sait	Care of Federal Dyestuff & Chemical Corp., Kingsport, Tenn.
R. P. Sauerhering	269-608 S. Dearborn St., Chicago
R. O. Scholz	921 Fifteenth St., Washington, D. C.
Frank H. Schwartz	4056 N. Lexington Ave., Chicago, Ill.
Chas. Shuman	24 W. Elm St., Chicago, Ill.
James Sorenson	511½ Cramer St., Milwaukee, Wis.
R. B. Stearns	245 State St., Boston, Mass.
John Stone	Aviation Corps, Ohio State University, Columbus, Ohio
James H. Ticknor	4441 Magnolia Ave., Chicago, Ill.
Fred Weber	Care of Vacuum Oil Co., Detroit, Mich.
Edward Wilmann	1462 Avenue G., Flatbresh, Brooklyn, N. Y.

MEMBERSHIP MATTERS

APPLICATIONS RECEIVED

Applications for membership were received by the Board of Direction since its meeting held May 16, 1921, as follows:

48 Emil Dasing (Transfer)................................1919 Warner Ave., Chicago
49 James E. Sellers (Transfer)........................P. O. Box 1006, Phoenix, Ariz.
50 Loren L. Whitney...............................1002 Hyslop Place, Hammond, Ind.
51 John Foster Kendrick...............................413 Peoples Gas Bldg., Chicago
52 Eugene A. Altman (Transfer).........................7350 Luella Ave., Chicago
53 Max A. Berns, Care of Universal Portland Cement Co., 210 S. LaSalle St., Chicago
54 Harvey M. Anthony.............................The Anthony Bldg., Muncie, Ind.

Members are requested to communicate with the Secretary with regard to qualifications of the above applicants for membership in the Society.

EDGAR S. NETHERCUT,
Secretary.

NEW MEMBERS

The change of the Society's fiscal year to June 1st necessitated the appointment of a new Membership Committee.

All applications for membership now pending will be acted on by this Committee and presented to the Board of Direction at its regular meeting in August.

EDGAR S. NETHERCUT,
Secretary.

ENGINEERING EMPLOYMENT

We wish to assist in placing valuable men in the employment most suited to them. Many concerns have positions open now or will have in the near future. What could be more logical than an engineering employer obtaining assistance from an engineering society, or an engineer looking for a position to seek a source that is in close tough with the engineering profession? You can co-operate by communicating with the Secretary's Office.

POSITIONS WANTED

B-1049: YOUNG ENGINEER WITH OIL REfinery, railroad, highway and building experience wants work in any of the above lines.

B-1048: GRADUATE ENGINEER WANTS POsition as experimental engineer. Experience in aerodynamical testing and experimental department of ventilating fan manufacturer.

B-1047: MECHANICAL DRAFTSMAN AND tracer with experience in coal handling machinery, grain elevators and railroad equipment wants work in above field.

B-1046: MECHANICAL ENGINEER WANTS A position in design or production, familiar with special machinery, also any phase of industrial work including time study and rate setting.

B-1045: SPECIAL MACHINERY DESIGNER, and designer of tools, jigs, fixtures and dies with experience in tool room and machine shop foreman to factory superintendent.

B-1044: WANTED—POSITION IN MACHINERY sales, steel or metal products; designing or detailing—mechanical structural or plate work; or superintendent, expediter, inspector, layer out or templet maker.

B-1043: POSITION WANTED IN RAILWAY terminal work (field or office), engineer or superintendent, charge of construction. Experience ten years terminal work, studies, development of plans and construction.

B-1042: ARMOUR GRADUATE WANTS POSItion as construction inspector, assistant superintendent on construction or instrumentman.

B-1041: MECHANICAL DRAFTSMAN WITH editorial experience wants position in above field.

B-1040: MECHANICAL DRAFTSMAN WITH eight years' experience including shop inspecting and erection work wants work in drafting or shop inspecting.

B-1039: GRADUATE ELECTRICAL ENGINEER, six years as sales engineer and four years manager open for position as sales or district manager.

B-1038: MECHANICAL DRAFTSMAN WITH experience in ventilation and exhaust drafting wants similar work or can handle clerical position.

B-1037: CONSTRUCTION ENGINEER WITH experience on bridges, buildings, highways and railroads, also four years' designing steel and reinforced concrete wants work on construction or in office.

B-1036: GRADUATE ILLINOIS 1918, WITH experience in factory work and sales promotion wishes to get into sales engineering.

B-1035: DESIGNER OF STEEL AND REIN-forced concrete with twelve years' experience on steel mill buildings, factories, by-product plants and power houses wants work in above field.

B-1034: POSITION WANTED BY GRADUATE M. E. Illinois 1909 as draftsman, heavy machinery or instructor mechanical drawing or mathematics. Has had practical shop experience in structural steel and boilers.

B-1033: GRADUATE ENGINEER PURDUE '17 wants outside work on building construction as resident engineer or assistant superintendent.

B-1032: MECHANICAL-ELECTRICAL DRAFTSman with five years' experience in above, also designer of special machines, wants permanent connection.

B-1031: STRUCTURAL AND MECHANICAL designer with six years' experience open for work.

B-1030: MECHANICAL ENGINEER WISHES work along power plant, maintenance, and fuel economizing lines. Can do drafting, structural or mechanical.

B-1029: POSITION WANTED AS REINforced concrete or structural steel designer of bridges, grain elevators and factories.

B-1028: FOREMAN OR SUPERINTENDENT construction wants work in above or as field engineer, general construction. Experience eight years.

B-1027: STRUCTURAL DESIGNER, STEEL and concrete, buildings and miscellaneous structures, open for work in above fields.

B-1026: WANTED WORK IN DRAFTING OR timekeeping during August only.

B-1025: SURVEYOR AND INSPECTOR, FAmiliar with office work, wants work in reinforced concrete and steel construction.

B-1024: MECHANICAL DRAFTSMAN WITH three years' experience wants drafting or clerical work in engineering office.

B-1023: POSITION WANTED AS POWER plant, mechanical, or building designer.

Engineering Employment, Continued

POSITIONS WANTED

B-1022: GRADUATE ENGINEER SEEKS work in mine or metallurgical plant. Prefers West.

B-1021: SUPERINTENDENT OF CONSTRUCTION open for such position. Can also handle position as maintenance superintendent.

B-1020: SALES ENGINEER DESIRES POSITION in selling or connection which will lead into sales work.

B-1019: STEEL DESIGNER AND DETAILER familiar with concrete design and architectural drawing open for engagement.

B-1018: POSITION WANTED AS CHIEF ENGINEER, Chief Draftsman, Office Engineer, Sales or Contracting Engineer by engineer with fourteen years experience in steel, concrete and heavy machinery.

B-1016: POSITION WANTED AS STRUCTURAL designer, building superintendent or estimator by engineer having wide experience in railroad and building construction.

B-1015: POSITION WANTED IN POWER House or Radio work. Experience in above fields.

B-1014: POSITION WANTED AS STRUCTURAL designer or structural detailer by University of Illinois graduate, 1916.

B-1913: POSITION WANTED IN OR AROUND Chicago as assistant to municipal engineer, draftsman on municipal work or transitman on channel improvements or reclamation survey.

B-1012: ENERGETIC ENGINEER, UNIVERSITY of Michigan graduate, desires to connect with engineering or manufacturing firm which may in the future be interested in development of sales of machinery or engineering project in Poland or Russia. Eight years' experience railroad construction, manufacturing and sales with leading U. S. A. concerns.

B-1011: POSITION WANTER FOR SUMMER only in mechanical drafting or shop work.

B-1010: POSITION WANTED IN CONCRETE design or assistant on concrete construction by graduate Purdue, 1921, having experience as chief of party on road survey.

B-1009: POSITION WANTED BY YUNIVERSITY student in electrical engineering course. Prefers connection which will give him practical experience. Summer months only.

B-1008: POSITION WANTED IN DESIGN OF bridges or buildings by graduate Armour, 1921.

B-1007: EXECUTIVE WITH EXPERIENCE IN management corporations and consulting engineers who understands office routine, accounting purchasing, employment, visiting and directing field work, negotiating contracts and compiling engineering reports open for engagement.

B-1006: GRADUATE ELECTRICAL ENGINEER open for connection with good concern.

B-1004: WANTED POSITION AS DRAFTSMAN or tracer. Two years at Lane Technical High School.

B-1003: POSITION WANTED AS ASSISTANT engineer, manager of small plant or testing work on electrical apparatus. Willing to begin as apprentice.

B-1002: POSITION WANTED IN RAILROAD valuation or construction work. Familiar with making expert investigations.

B-1001: POSITION WANTED AS DESIGNER of dies, jig or tool work or on automatic stokers.

B-1000: WANTED, TEMPORARY POSITION for summer only; railroad or industrial work.

B-999: POSITION WANTED IN RAILROAD valuation; experience seven years.

B-998: GRADUATE ENGINEER AND LAWYER wishes to connect with responsible company as engineer assistant to valuation counsel. Also would consider position as valuation engineer or engineer on construction.

B-997: POSITION WANTED IN SURVEYING or outdoor work.

B-996: POSITION WANTED AS GENERAL manager, works manager, or superintendent in research or development work along metal manufacturing lines.

B-995: MECHANICAL ENGINEER WITH EXPERIENCE on oil burning furnaces or allied industrial engineering problems; six years; open for engagement.

B-994: POSITION WANTED FOR SUMMER only in engineering office.

B-993: POSITION WANTED WITH CONSULTING engineering firm who specialize in power plant work.

JOB 2851—West. Soc. Engineers—Galley 19—

B-992: POSITION WANTED AS INSTRUMENT man or rodman, with railroad experience.

B-991: POSITION WANTED AS SURVEYOR, steel designer or concrete inspector; experience two years.

B-990: POSITION WANTED IN MECHANICAL designing; tools, jigs, and fixtures, machine shop efficiency, or time study. Experience six years.

B-989: POSITION WANTED IN ELECTRIFICATION of railroads, power plant work or railway purchasing, by graduate Massachusetts Institute Technology, 1914.

B-988: POSITION WANTED IN CHECKING or detailing structural steel. Experience five years.

B-987: POSITION WANTED IN STRUCTURAL or railroad engineering field by graduate Armour, 1919.

Engineering Employment, Continued

POSITIONS WANTED

B-986: POSITION WANTED AS CONCRETE wood or steel engineer. Can take full charge of mill building.

B-985: POSITION WANTED AS INSTRUMENT man or rodman, on highway work.

B-984: CHIEF ENGINEER WHO HAS HAD charge of operation and maintenance of central station and industrial steam-electric power plants open for engagement. Experience twenty years. Good knowledge of boilers, stokers, turbines, condensors, feed water heaters, pumps, compressors and refrigerating systems.

B-983: POSITION WANTED IN POWER plant work, or engineering sales.

B-982: POSITION WANTED BY GRADUATE Mechanical Engineer, with experience as draftsman, designer, erection, production, maintenance and sale sengineer in executive capacity or sales engineering.

B-980: POSITION WANTED AS PRODUCTION, Industrial or Sales Engineer by graduate M. E. Armour, 1916. Experience four years, covering broad mechanical field.

B-979: POSITION WANTED IN SALES OR Office Work by graduate M. E. Michigan, 1900. Thirteen years in one position.

B-978: POSITION WANTED IN ELECTRO-metallurgical plant using electric furnaces, or in small manufacturing plant where mechanical electrical experience can be utilized.

B-977: POSITION WANTED BY GRADUATE Electrical Engineer, Armour 1917, as equipment engineer or any position leading up to engineering sales.

B-976: POSITION WANTED IN THE ELECTrical field, Chicago or vicinity, by student who will be available during June, July and August.

B-975: POSITION WANTED IN MECHANICAL and electrical executive position or testing. Would consider technical writing or general literary work. Experience includes assistant professorship in steam engineering.

B-974: POSITION WANTER IN POWER plant design or assistant to consulting engineer. Experience three years as above.

B-973: POSITION WANTED AS DRAFTSMAN, mechanical or electrical. Seven years experience including electrical operating work.

B-972: POSITION WANTED AS STRUCTURAL draftsman. Experience five years.

B-971: POSITION WANTED IN INSPECTION, supervision and reports on public utility properties or industrial plants. Principally mechanical engineering with possibility of application of electriacl. Experience broad, including five years consulting.

B-970: POSITION WANTER AS MECHANICAL draftsman or tracer. Experience six years.

B-969: POSITION WANTED AS CHIEF draftsman, designer, superintendent or estimator. Experience fourteen years including reinforced concrete, flat slab, structural steel and wood.

B-968: POSITION WANTED AS SURVEYOR or outdoor work.

B-967: POSITION WANTED DURING SUMmer in electrical drafting or testing.

B-966: POSITION WANTED AS DRAFTSMAN on special work and machinery during July and August. Experience six years. At present instructor mechanical engineering.

B-965: POSITION WANTED AS CONSTRUCTION engineer, assistant city engineer, or outside civil engineering work. Experience four years. Sewers, waterworks and on general construction.

B-964: POSITION WANTED AS COMBUSTION maintenance or power engineer. Experience twelve years.

B-963: POSITION WANTED AS CHIEF, OPerating or maintenance, ice plant construction or operation, also electrical construction work. Experience sixteen years.

B-962: POSITION WANTED AS MECHANICAL draftsman, detailer or letterer. Experience in heating, plumbing, power plants and conveyors, foundries.

B-961: POSITION WANTED BY CIVIL ENGINeer at present employed by large railroad. Wishes to locate in Chicago or vicinity account wife's ill health.

B-960: POSITION WANTED AS REFRIGERAtion Engineer, executive in manufacturing plant or maintenance engineer in power plant.

B-959: POSITION WANTED AS DISTRICT highway engineer, superintendent on sewers, water, or municipal work. Experience twenty years as engineer in charge of construction, sewers, waters and paving work.

B-958: POSITION WANTED IN BUILDING design or oenstruction by graduate architectural engineering course. At present employed away from Chicago but is looking for a local connection.

B-957: POSITION WANTED WITH CONSULTing engineer on municipal, water supply, sewage treatment or hydro-electric development work. Experience seven years in above fields.

B-956: POSITION WANTED AS MECHANICAL engineer or designer on bascule bridges, power plants, waste disposal plants and in general engineering work.

B-955: POSITION WANTED AS SUPERINtendent of construction, architectural or structural draftsman. Experience seven years.

Engineering Employment, Continued

POSITIONS WANTED

B-954: POSITION WANTED AS ENGINEERING executive, or sales engineering, in good line or can invest with services in engineering company, architect or manufacturing concern.

B-953: POSITION WANTED IN HEATING, ventilating ,plumbing or electrical work. Experience also in mechanical equipment.

B-952: POSITION WANTED AS STRUCTURAL designer, concrete or steel. Experience six years. Graduate Armour C. E., 1915.

B-951: POSITION WANTED AS ENGINEER on concrete construction or sales engineer, railway equipment or supplies. Graduate engineer, 14 years' experience on railway construction, maintenance and water supply.

B-950: POSITION WANTED IN RAILROAD, Industrial or Highway Work. Experience, 17 years drafting, estimating, field and supervision, including resident and division engineer. What have you to offer?

B-949: POSITION WANTED BY GRADUATE C. E. having 20 years' experience office and outside work in roadway, construction, bridges, buildings, land valuations and contracts.

B-948: POSITION WANTED AS DESIGNER or production superintendent. Experience, 12 years in mechanical an d electrical fields. Would like to make connection where there is field for improvement of products or methods and developing new machines.

B-947: POSITION WANTED IN DRAFTING or tracing by young woman with three years' experience.

B-946: POSITION WANTED AS DRAFTSMAN on mechanical drawings and details—Civil, Electrical, Mechanical and Construction work. Also design and detail sof electrical apparatus

B-945: POSITION WANTED AS ARCHITECTURAL draftsman or superintendent on building work. Experience, 18 years.

B-944: POSITION WANTED AS SALES ENGINEER, advertising or estimates on mechanical equipment or building products. Experience, 7 years.

B-943: EXTRA WORK SATURDAY AFTERNOONS and evenings, preferably to take home. Drawing and drafting, computing, designing, surveys. Map drafting, track layouts, structural detailing, checking. Experience, 10 years.

B-942: POSITION WANTED AS DESIGNER of steel structures, checker or squad foreman. Experience, 16 years. Prefer work in Chicago.

B-941: POSITION WANTED AS CONSTRUCTION inspector in Chicago.

B-940: POSITION WANTED AS CONSULTING or supervising engineer with Chicago concern. Prefer office work.

B-939: POSITION WANTED AS ENGINEER or superintendent on construction, maintenance, operation, or track elevation preferred. Experience, 6 years.

B-938: POSITION WANTED AS MECHANICAL draftsman on piping. Experience, 10 years as draftsman, designer, detailer and checker.

B-937: POSITION WANTED IN MECHANICAL of electrical engineering, plant evaluation or efficiency work. Nine years' experience.

B-936: POSITION WANTED—YOUNG MAN 21 years old. Experience, three years on heating and power plant equipment. Wishes work outdoors along mechanical lines.

B-935: POSITION WANTED AS STRUCTURAL designer. Familiar with concrete design. Experience in office and mill buildings, smelter structures, and theaters.

B-934: POSITION WANTED BY GRADUATE C. E. as superintendent of construction or on special investigations, making estimates and plans in connection with water and coaling stations.

B-933: POSITION WANTED AS WORKS maintenance engineer, office or sales engineer, mechanical. Can handle large ojbs as well as men and systems.

B-932: POSITION WANTED AS STRUCTURAL Engineer, field or office. Experience, 9 years.

B-931: POSITION WANTED IN DESIGNING, detailing, estimating steel and concrete, including coal tipples.

B-930: POSITION WANTER IN INDUSTRIAL engicnering and management, illuminating engineering or electrical maintenance. Experience, 14 years as executive, electrical and mechanical engineer, drafting, accountant, statistician, designer, economist, plant construction an doperation.

B-929: POSITION WANTED AS ASSISTANT to factory superintendent or superintendent of construction (power plant work), or sales engineer, mechanical. Experience, 8 years in above work.

B-928: POSITION WANTED AS INSTRUMENTMAN or draftsman. Experience on R. R. track elevation work and valuation, drafting and designing on concrete work and concrete products plant.

B-927: POSITION WANTED AS ASSISTANT to vice-president, assistant to consulting engineer or sales engineer by gradaute M. E. Experience on inspection and building, also sales engineer, steam specialties for power plants.

B-926: POSITION WANTED AS SALES ENGINEER in hosting machinery or heavy contractors' equipment. Five years' selling experience.

SECRETARIES OF ENGINEERING SOCIETIES
CHICAGO, ILL.

Organization	Secretary	Address	Telephone
Am. Soc. C. E. (Illinois Section)	W. D. Gerber,	913 Chamber of Com.	Franklin 2243
A. S. M. E. (Chi. Section)	J. D. Cunningham,	2240 Diversey Blvd.	Armitage 254
A. I. E. E. (Chicago Section)	E. H. Bangs	Ill. Bell Tel. Co.	Off. 300
A. I. M. E.	F. G. Fabian,	1025 Peoples' Gas Bldg.	Har. 470
Am. Ry. Engrg. Assn.	E. H. Fritch,	431 S. Dearborn St.	Har. 1069
Am. Chem. Soc.	S. L. Redman,	460 E. Ohio St.	Sup. 7920
Am. Soc. Htg. & Vent. Engrs.	Benj. Nelson,	1301 Monadnock Blk.	Wab. 9038
Am. Soc. Refrig. Engr.	Thos. McKee,	431 S. Dearborn St.	Har. 5643
Am. Steel Treaters Soc.	H. Blumberg,	Ill. Steel Co., S. Chgo.	S. Ch. 4000
Am. Inst. Architects	Ed H. Clark,	8 E. Huron St.	Sup. 1461
Assn. I. & S. Elec. Engrs.	W. H. Williams,	1501 Monadnock Blk.	Har. 1190
Am. Assn. of Engrs.	W. H. Dean,	29 S. LaSalle St.	Cent. 73
Am. Welding Soc.	L. B. Mackenzie,	608 S. Dearborn St.	Wab. 7134
Ill. Soc. of Architects	Ralph C. Harris,	192 N. State St.	Rand. 2409
Ill. Soc. of Engrs.	E. E. R. Tratman,	1570 Old Colony Bldg.	Har. 2196
Illuminating Eng. Soc.	Jas. J. Kirk,	72 W. Adams St.	Rand. 1280
Natl. Assn. Prac. Ref. Engrs. (Chgo. Sub.)	A. J. Plocinsky,	1505 S. St. Louis Ave.	Rand 6984
Soc. Automotive Engrs. (Mid-West Section)	L. S. Sheldrick,	910 S. Michigan Ave.	Har. 1455
Soc. Industrial Engrs.	Geo. C. Dent,	327 S. LaSalle St.	Wab. 3291
Struct. Engrs. Assn.	John P. Cowing,	30 N. LaSalle St.	Frank. 778
Swedish Eng. Soc. of Chicago	C. H. Mayer,	404 Monroe Bldg.	Rand. 6120
Western Society of Engineers	E. S. Nethercut,	1736 Monadnock Blk.	Har. 945

JOURNAL OF THE

WESTERN SOCIETY *of* ENGINEERS

Volume XXVI SEPTEMBER, 1921 Number 9

PROGRAM COMMITTEE

E. T. HOWSON, Chairman

SEPTEMBER PROGRAM

In presenting the program for the opening month of the Society's year, the Program Committee offers it as typical of the meetings which it has in contemplation during the year. It is concentrating its efforts on the selection of those subjects which it believes will be of the greatest interest to the members of the Society and is then endeavoring to select those men whom it believes are best qualified to present these subjects. It is the hope of the Committee to bring before the Society representatives of the best enginering talent in the country. To do this it is necessary that the meetings have the support of the membership, for speakers of the calibre which the Committee is endeavoring to secure are not willing to prepare papers at considerable sacrifices in time and energy to present them before small groups.

The Program Committee believes that the subjects and speakers selected form a combination which every member of our Society can derive benefit from. The success of the Committee's efforts will largely depend upon the support the Society gives it during the early meetings of the year.

DEVELOPING A SYSTEM OF HIGHWAY TRANSPORTATION TO SERVE THE PEOPLE OF A STATE.

September 12th, 1921.

A. R. Hirst, *State Highway Engineer of Wisconsin.*

A highway department exists to give transportation service. This is the doctrine, the creed, the criterion by which A. R. Hirst, State Highway Engineer of Wisconsin, tests every decision. Whether it be the order in which a concrete road is to be constructed or the character of surfacing between Gopher Prairie and Baraboo, the first consideration is, —will traffic be effectively and inexpensively served? Hirst knows that the user cares little about highway economics, but he does recall vividly where he broke the last spring. Wisconsin roads are maintained by the Patrol System and they are marked. Every week this season 90 hotels and garages were furnished new blue-prints indicating road conditions and detours.

Without delaying traffic, Hirst is building this year 2,200 miles of road, 325 miles of concrete, 1,200 miles of other surfacing and 700 miles of grading. Sixty mixers and 175 construction crews are at work. A concrete road costs more than the book value of most of the Middle West railroads, but isn't it a long time since 325 miles of rails were laid? The highway engineer has all the difficulties of the railroad engineer, besides being a public servant. You are a stockholder in this enterprise. Come and hear where your tax money goes.

Other state highway engineers have written that they expect to be present at this meeting.

FLOOD CONTROL MEASURES IN THE VICINITY OF DAYTON.

September 19th, 1921.

Arthur Morgan, *Chief Engineer, Miami Conservancy District.*

Flood control in the Miami River Valley in Ohio is virtually accomplished. Another year will see the completion of the five retarding dams ,the channel widening and the levee construction. Some forty million dollars will

have been spent. Dayton and its sister cities of the valley will never again experience a disaster like the flood of 1913. This result has been due largely to Arthur E. Morgan and an engineering staff selected with a strict regard to technical ability and practical capacity to secure results. Engineering domination has existed all through the work from the early period of data collection to the construction period now drawing to a close. The engineer has been paramount, his ways have had precedence, he has materialized his ideas in his own way. Mr. Morgan will tell how all this was done.

CHIEF ENGINEER'S NIGHT.

September 26th, 1921.

Chicago is the greatest railway center in the world. As such more large railways have their headquarters and general offices here than at any other point. As a result more leading chief engineers are resident in Chicago and are enrolled in our membership than in any other local engineering society in the world.

It is the ambition of every young man to attain success in his chosen line and to arrive at the top. He is watching those who have arrived and is striving to emulate their methods with the hope that he may likewise achieve success. From his more or less remote contact with the man at the top of his profession he sometimes loses sight of the fact that they have held positions in their earlier days similar to that which he is now holding, that they have had the same problems, troubles and worries, and that they have pulled themselves above the mass to achieve the positions which they now hold.

Taking advantage of the fact that more chief engineers of large railway properties are located in Chicago than in any other city, and that the young men will eagerly welcome an opportunity to see and meet these men and to hear from them some of the stories of their earlier experiences which they regard as the turning point in their professional careers, the Railroad Section has arranged for a Chief Engineer's Night on Monday, September 26, at which C. A. Morse, Chief Engineer of the Chicago, Rock Island & Pacific System; A. S. Baldwin, Vice-president and formerly Chief Engineer of the Illinois Central System; H. R. Safford, Assistant to the President of the Chicago, Burlington & Quincy and formerly Chief Engineer of the Grand Trunk System; C. F. Loweth, Chief Engineer of the Chicago, Milwaukee & St. Paul System, and E. H. Lee, Vice-president and General Manager and formerly Chief Engineer of the Chicago & Western Indiana, will speak. Other Chief Engineers will participate in the discussion. This is the first of a series of inspirational programs which is in contemplation. While it will be of particular interest to engineers in railway service, it should also have a strong appeal to all engineers ,particularly the younger men.

COMMITTEE PROGRESS REPORTS

MILITARY COMMITTEE
MURRAY BLANCHARD, Chairman

ANNUAL REPORT.

The following is a report of your Military Committee for the year and a half ending May 31st, 1921:

The work of securing as complete as possible a record of the war service activities of the members of the Society, started by our predecessors, the Military Committee of 1919, was continued. On account of the increase in membership and in an effort to obtain replies from those who had not answered the first request, a second questionnaire was prepared and set out to the entire membership. The replies giving both Military and Civilian Service records have been arranged in alphabetical order and compiled in a loose leaf binder for reference in the library.

Another work started by the last Military Committee and completed this year was the securing for the States Publications Society of the war records of the Illinois Engineers who were in the military service. That society proposed to publish the data as a chapter in a memorial book of several volumes entitled "Illinois in the World's War." Thus far only the first volume containing the record of the 33rd Division has been published. It appears that lack of funds is the cause if the delay in publication of the other volumes. They propose to eventually complete the work. A copy of the records secured has been typewritten and compiled in alphabetical order in a loose leaf binder for reference in the library.

At the time that the questionnaire regarding service record was sent out another questionnaire was enclosed requesting the opinions of members of Universal Training and the organization of reserve units. A tally of the replies was made and tabulated in a recent number of the society proceedings.

An effort was made to determine whether or not this committee could render any assistance toward the formation of an engineer regiment in the Illinois National Guard. We were advised by Colonel Henry Allen that there was apparently nothing the society could do at present and that as soon as anything developed wherein we could assist, the society would be called upon.

It is the recommendation of the committee that a Military Committee be appointed again for the coming year and that they keep in touch with the engineer post of the American Legion and the Chicago Section of the Society of American Military Engineers so as to co-operate in any military activities where they might be in a position to assist.

PERSONAL NOTES

Secretary Stoughton Resigns

Mr. Bradley Stoughton, after having served for more than eight years as Secretary of the American Institute of Mining and Metallurgical Engineers, has tendered his resignation to the Society. This resignation has been accepted and Mr. Stoughton has resumed practice of consulting engineer with headquarters in New York City.

Many important developments in society matters have transpired during the service of Mr. Stoughton and in which he had a very leading part. The well wishes of all members of his Society and his numerous friends among other engineering societies goes to him in his new position.

Mr. Frederick F. Sharples was elected Secretary of the American Institute of Mining and Metallurgical Engineers at the meeting of its Board of Direction held June 24, 1921. Mr. Sharples was born in Pennsylvania in 1866 and is a graduate of the University of Michigan; he has had wide experience as a teacher and as a consulting engineer in this country and abroad. Mr. Sharples brings to the office of Secretary unusual attainments and the Society is to be congratulated on having as able a successor to Mr. Stoughton.

Joachim G. Giaver, M. W. S. E., has been honored by the King of Norway, who has conferred upon him the highest honorary order of the Norwegian Government,—the Order of St. Olaf, First-class. Mr. Giaver is senior partner of the architectural firm of Giaver & Dinkleberg, and came to Chicago in 1892 as Assistant Chief Engineer for the World's Columbian Exposition.

Dr. R. A. Millikan, Professor of Physics, Chicago University, has accepted the presidency of the California Institute of Technology at Pasadena, California, and will assume his duties on the first of October. The address, which Dr. Millikan presented before the Annual Meeting of the Western Society of Engineers last June and which was published elsewhere in this Journal, was an inspiring outlook for the future of engineering research.

Dr. Millikan in his new connection will have a wonderful opportunity of putting into effect the higher training of engineers so as to fit them more fully to do the work of engineering as a profession.

Dr. Philip B. Woodworth, member Western Society of Engineers, President of Rose Polytechnic Institute, has been appointed a member of the Advisory Board of the War Plane Division, General Staff, at Washington. During the war Dr. Woodworth organized the educational work in all the military camps in the Central Department and is recognized as authority on all these matters.

Geo. C. D. Lenth, M. W. S. E., has been appointed Secretary of the Clay Products Association, Chicago, succeeding Geo. H. Tefft, deceased. Mr. Lenth was formerly with the Board of Local Improvements, City of Chicago.

J. O. Kilman, M. W. S. E., has accepted a position with Allen & Garcia Company, Chicago.

David Davis, M. W. S. E., has removed to South America. He formerly lived at 5122 University avenue, Chicago.

Theodore Doll, J. W. S. E., returns to Northwestern University this month to enter upon his fourth year as Instructor of Mathematics.

J. E. Love, A. W. S. E., again recently passed around the cigars. This time it was a girl. Congratulations!

E. R. Webster, M. W. S. E., is on an extended business trip in the West.

Robert Quayle, M. W. S. E., has been spending a vacation with his family at their summer home, "Heart's Delight," Ludington, Michigan.

A. S. Shay, J. W. S. E., has recently opened a garage and repair shop at 3324 Jackson Boulevard, Chicago.

Emmet Marx, J. W. S. E., has accepted a position with H. M. Byllesby Company, Chicago.

John A. Dailey, M. W. S. E., has returned from his vacation in Michigan. Mr. Dailey is Chairman of the Young Men's Forum this year and expects to have an interesting program outlined for the season.

Robert B. Harper, M. W. S. E., has returned from a motor trip to New York State. Mr. Harper says the roads were quite good and the scenery and weather could not be equalled.

D. C. Wray, M. W. S. E., Operating Manager, Mineral Point Zinc Company, DePue, Illinois, was a recent visitor at the Society rooms.

Francis J. Dvorak, A. W. S. E., formerly with the Engineering Department, American Bridge Company, Chicago, has removed to Prehy, Czecho-Slovakia.

Dana D. Higgins, M. W. S. E., has been promoted to Assistant Chief Engineer, Northwest Station, Commonwealth Edison Company. Mr. Higgins was formerly Chief Electrician of the same station.

and Manager of Municipal and County Engineering, has moved to Indianapolis. His paper is now published at the new headquarters, 702 Wulsin Bldg., Indianapolis, Ind.

A. Epstein, M. W. S. E., who for the past four years has been associated with S. Scott Joy, Architect, has re-established his connection with the Central Manufacturing District, Chicago, as Construction Engineer. He is located at 2001 West Pershing Road.

Edwin A. Howes, M. W. S. E., formerly with the Sanitary District of Chicago, is agent for the Guarantee Fund Life Association of Omaha, Neb. Mr. Howes is located at 5340 Winsor Ave., Chicago.

FROM THE SECRETARY'SOFFICE

Edgar S. Nethercut, Secretary

Declaration of Principles Underlying Working Agreement Between Labor Union and Contractors' Ass'n.

Judge Landis has been working for a number of weeks in an attempt to settle the difficulties between the Labor Unions and the Building Contractors of Chicago. During this time, the work on buildings has progressed under the old agreement as to rules and wages. Progress, however, has been slow in getting a final settlement.

Recently Judge Landis has submitted a series of three articles, which, he declares, should be insisted upon and must underlie all working agreements. Our members will agree with the position taken by Judge Landis. We reproduce these articles for a record in our Journal. They are as follows:

"ARTICLE 1. Monopolistic elements of associations or unions are intolerable unless:

(1) The public is served more economically with them than without them.

(2) Unless any one qualified may join them without hindrance or discrimination.

(3) Unless they serve any one on demand without discrimination.

(4) Unless sufficient apprentices be taught to supply enough skillful managers and workers.

(5) Unless working rules and conditions eliminate waste of time, effort and material; increase quality and qauntity of product; encourage improved methods, materials and appliances; produce increased skill and contentment of the workers; and help to preserve peace in the community.

"ARTICLE 2. Other things being equal, trades should have higher wages, or wages above the average.

(1) If the work is more hazardous.

(2) If greater skill is required.

(3) If a longer term of apprenticeship is required to become proficient.

(4) If the work is intermittent or unsteady, due to weather or seasonable demand.

"ARTICLE 3. Other things being equal, trades having rules or conditions that produce or permit waste should have a lower wage, or a wage lower than the average rate.

1. Rules that limit or curtail in any way the amount of work per man, consistent with reasonable comfort and well-being.

2. Rules that require ordinary travel to or from the job to be on employers' time, or otherwise waste time paid for.

3. Rules requiring skilled men or high-rate men to do work that less skilled or lower-rate men could do, or that other trades could do more economically.

4. Rules that expressly or by inference interfere with the manager or foreman in the dispatch of the work or the use of new or improved methods, materials or appliances.

5. Rules that require work to be done by hand that could be done better or more economically by machinery, tools or other improved methods.

6. Rules that require work to be done on the building that could be done better or more economically in the shop.

7. Rules requiring excessive rates for overtime, or overtime rates for shift work.

8. Rules requiring unnecessary foremen, shop or job stewards or pay for men or the time of men who do not render corresponding services.

9. Rules requiring unnecessary helpers or assistants.

10. Rules that limit the number of members in the associations or unions, or unreasonably limit apprenticeships."

Working agreements, based upon a clear statement of principles will have the element of stability. Progress in building construction can be hoped for when all parties agree to articles as outlined by Judge Landis.

"Engineers" So-Called

A recent New York dispatch to a Chicago paper is published with the following heading:

"ENGINEERS HALT WATER
FRONT WORK IN NEW YORK"

STRIKE TIES UP COMPLETION OF $80,000,000 IMPROVEMENT.

Reading the article, which is brief, we find that a strike of forty stationary engineers tied up the completion of New York's $80,000,000 Water Front improvement on the south shore of Staten Island.

This indicates that a small group of the members of a trade are now holding up and preventing the completion of an improvement,

which was designed by engineers and by whom it was being superintended and under whose direction it will be completed. Engineers, as we understand the term, are the people who are responsible for the conception and the design and construction of this great improvement, which would not only provide a great benefit to all but it also would provide, if carried on to its completion in a reasonable way, employment for many hundreds of men at a living and profitable wage. Instead of them being responsible for the halting of this work, the engineers should be commended upon their efforts to initiate the work and planning it so that it could be successfully constructed and completed.

What a short-sighted policy we are required to endure, which because of the confusion in the name of a profession with that of a trade, which in the minds of the unthinking reader, lays the blame where it does not belong.

Engineering Education

At the summer meeting of the Society for the promotion of Engineering Education, Prof. Wm. H. Burr presented a brief paper outlining some of the possibilities of an Engineering Education, which would tend to upbuild the profession of engineering.

This paper is on file in our library and is worth consideration by those of our members who are interested in Engineering Education.

Regarding professional status, Prof. Burr has the following to say:

"For some reason members of the principal engineering societies and associations of this country are deeply dissatisfied with their professional status as indicated by the failure of the public, as they claim, to give members of the profession proper consideration in their professional work. There have been many meetings, joint and individual, of these societies and associations, for the purpose of discussing this failure to receive sufficient professional recognition from the community at large."

Prof. Burr then discusses the history of the present four-year engineering course and its limitations. Prof. Burr's recommendation is for a six-year course leading to a full engineering degree. First three years to be given to those studies which are fundamental, together with such cultural studies as will enable the engineer to take his place as a citizen on an equal plane with the members of other professions; the last three years could then be given to those studies which are considered as purely educational. Prof. Burr says:

"The engineer must be made a man of cultivation as well as of technical excellence. In order that he may become the most useful citizen possible, he must combine with his rather narrowing technical excellence those qualities which give character and standing as an individual qualified to win the esteem and respect of those about him for his executive capacity wherever he is found to possess the executive quality. In other words, he must be a man entitled to receive the confidence of the community in which he practices."

Engineering education has been considered a quick road to self-support. Under normal business conditions the technical graduate finds that he is able to make a fair living. The first few years out of college, however, find it necessary for him to serve a sort of apprenticeship if he intends to follow engineering as a profession, and this apprenticeship should be under professional advice. The engineering society has a large function in the development of the young technical graduate and those who avail themselves of the advantages of a technical society, will find that their advancement in the profession is enhanced by such attendance and participation in the affairs of the society.

Dr. Robert A. Millikan, Professor of Physics, University of Chicago, in a recent address before the Indiana University at Bloomington, Indiana, outlined many of the difficulties and the possibilities of engineering education. This address was entitled "A Present Need in American Professional Education."

By permission of Indiana University, we are able to print this address herewith.

A PRESENT NEED IN AMERICAN PROFESSIONAL EDUCATION

By Robert Andrews Millikan.

I wish to present in the briefest possible compass what, from my point of view, is the outstanding deficiency in technical and engineering education in the United States. The undertaking may seem a bit presumptuous in a man who has spent his life in the pursuit of pure science, and who is today connected with an institution which has no engineering school. I have myself taken, however, a considerable part of the engineering-school course; I have been thrown in my work into the closest contact with the engineering societies and with the most prominent men in the engineering profession; I have been a close student of several types of technical developments in the United States, and I had exceptional opportunity, during the recent war, to see the results of our scientific and technical efforts, when we were called upon to exert ourselves to the utmost and to get results in the shortest possible time. Permit me first to present a few concrete illustrations of the results of these experiences.

It is to the eternal credit of the United States that the two most significant and important advances of the last half-century in scientific and technical lines have had their inception in this country. The conquest of the air by man after centuries of failure is due almost entirely to Americans. The names of Wright, Chanute, and Langley, the three most potent names in the history of this achievement, are all, I am proud to say, American names.

Again the science and art of the electrical transmission of speech has been an American product. There is scarcely a foreign thread in the whole fabric of its development. Bell and Grey, the original discoverers, were both Americans. The big advance made by Pupin in the introduction of the loaded line is the result of work done in an American university, and the immense advance which has recently been made in the development and use of vacuum tube repeaters and amplifiers, which are now finding applications in an extraordinary number of commercial fields, is wholly an American achievement. Of these things we may be extravagantly proud.

Now look into the other side of the picture. Despite the fact that the conquest of the air was first achieved in this country, when the war broke out, we were so far behind France, England, and Germany in the development of the art of aviation that we couldn't see their dust. During the war (barring the development of the Liberty motor—a credit to America) we attempted to do nothing in aviation except to copy British, French, and Italian planes. Why? Because these nations had so much better planes than we had produced, or could hope to produce in quick time, that the only wise course was to copy foreign makes. But why had we not already produced equally good ones? Because the American public had not had a sufficient appreciation of the possibilities and the needs of this sort of scientific work to adequately support it, and because we had not in this country developed a sufficient number of men of outstanding ability in this field to enable us to keep neck and neck with our European competitors.

The story of the application of the vacuum tube to the purposes of the war is remarkably similar. We thought we led the world in this field, but the special commissioner whom General Squier sent to Europe to study European developments in signaling came back and reported that the British and French had greatly outdistanced us in applying these newer developments to the purposes of the war. A high official in the company which was itself responsible for the original application of vacuum tubes to telephony corroborated to me this statement, and at the meeting of the Physical Society in Chicago in November one of the most prominent of our own radio engineers declared, "I take off my hat to the young British radio engineer."

The same sort of a story comes from many other fields of activity. I was recently standing with a prominent American chemist who was on the front in a responsible post in the American Chemical Warfare Service. He showed me a German gas mask with the remark, "I want you to see the best gas mask which was developed during the war." "Why", said I, "my chemical friends told me that the American mask was superior to all others." Said he: "It was beyond all question the poorest mask which actually was in use at the front, in absorbing power for the gas which it was called upon to protect against. The quantitative tests of the research department of the Chemical Warfare Service of the A. E. F. showed the various masks to run somewhat like this: German 100, English 70, French 40, American 10 or 15."

Now let us frankly admit the possible unrepresentative character of the foregoing showings because of the tremendous stimulus of immediate and dire necessity under which our European friends worked, in contrast with our own remoteness from the scene of conflict, and let us make a comparison which has nothing to do with the war.

Will anyone who knows anything about the situation for a moment claim that when we count up the world's outstanding men in scientific and technical lines the number of American names in comparison with those belonging to England, France, and Germany is in any way proportionate to our population? Certainly not in my own field. Here we cannot show more than a half or a third of our proper proportion. In the field of chemistry one would scarcely think of comparing the group of men whom we have produced during the past thirty years with those who have honored Germany, and I suspect that physics and chemistry are fairly representative of most of the sciences. To what then is the deficiency due?

I do not think that it is due to a lack in the native capacity of men born on American soil, and I have a little evidence upon this point which I should like to present. During the past thirty years we have had opportunity in the graduate work at the University of Chicago to compare the students who come to this department from all over the United States and from Canada. Now the population of Canada is exceedingly similar to that of certain portions o four own country. But we have learned to expect an exceptional man when we get an honor student from Toronto or McGill. In a word, it seems to me that the British honor system has had a greater success in one particular than has our own

educational system, namely *in selecting and giving exceptional training to the exceptional man.* Our great public educational system has done one thing which is immensely vital to progress ;it has raised the average intelligence of our people to a very high level. But it is even more vital to progress to select and to train leaders intensively, for is it not her Newtons and her Faradays and her Maxwells who have made England what she is?

I would not detract from our public educational system, but I think attention must be directed to the task of superposing upon it something which it now lacks, and which European educational systems do not lack in any such degree.

Particularly in engineering education have we focussed attention upon *quantity rather than quality.* Unlike law and medicine, the standard engineering course has remained a four-year course instead of a six or a seven-year course. Again, the teaching of the details of industrial operations has crowded out to an ever-increasing extent thorough training in the fundamentals, that is, in mathematics, in physics, and in chemistry. The old four-year engineering course may do for the routine operating engineer, but it will not do for the creative engineer. If he is to compete on equal terms with his British, French, or German comrade, he must get, in his undergraduate course, a more thorough training than he now gets, primarily in mathematics and secondarily in physics and chemistry, and he must then do Ph.D. work in a university, or else he must get the equivalent training through additions made to the curriculum of the technical school. Perhaps the former is the better solution; but in any case if we are to keep our place in the forefront of the nations ,it is imperative that we find a better way than we seem to have yet discovered for selecting and intensively training men who have the capacity to become the world's leaders in science and its applications to industry, for if anything has been demonstrated by the history of the last hundred years it is that that nation which is foremost in ferreting out nature's secrets and in applying them to her industry and her commerce will be the world's leader and teacher in practically all lines of human effort. The problem which Dean Pound has just referred to as the age-long problem of mankind, namely that of finding how to make the world's goods go around, despite its great importance, is not the most vital of our modern problems. It is another problem which must command at least some of the finest brains which this world can produce, a problem which, with suitable selection of brains and suitable training, the scientist and the engineer together will solve. It is the problem of the creation of enough to go around. The total possibilities of improvement by finding some new mode of distribution are exceedingly limited, while the possibilities in the matter of creation of new wealth are well nigh infinite and no price is too much to pay for the selection and the training of the men who have the capacity to realize them.

So far our immense supply of easily accessible wealth has made us the most prosperous and the happiest country in the world. We were producing before the war from two to five times as much per man-hour in practically all lines of industry as were European nations, and the common man, the unskilled laborer in this country, was receiving from two to five times as much for his labor in actual purchasing power. The parallelism in the figures is not accidental. We had no better mode of distribution of wealth than had other countries. *Our labor received more because it produced more, and in just about the proportion in which it produced more.* The inequalities in distribution are glaring enough and they need remedying, but they are of very much less general significance than they seem to be to the superficial observer. If we are to maintain our prosperity and increase it, there is in the long run but one way in which we can do it, namely *by maintaining and increasing our production.*

But our easily accessible wealth, our timber, our surface coal ,our soil, our most accessible iron and copper are disappearing. There is but one way in which our prosperity may be maintained, namely, by growing the brains which can devise new processes, discover new sources of energy, make the desert a garden, conserve human life, and teach the rational control of population. These results cannot be brought about by superficial scientific and engineering education. Such problems require the most careful selection and the most thorough training of our creative men which we can devise. The big need in American professional education today is for *a better means than we now have of selecting and training the* ***exceptional man.***

Attendance at Technical Meetings

Below is given a table showing the average attendance at the meetings of the Western Society for the past two seasons. It is interesting to note that the attendance at meetings of the various Sections is quite as large as for the general meeting the first Monday of the month. The increased attendance for the past year indicates a growing interest in the very excellent programs that are being given through the efforts of the Program Committee.

Elsewhere in this issue will be found the program for September and information on the October meetings, all of which will very likely have a large attendance.

AVERAGE ATTENDANCE.

Section.	1919-1920.	1920-1921.
General Meeting	97	128
Bridge and Structural	90	77
Electrical	85	221
Gas	39	42
Hydraulic, Sanitary and Municipal	104	67
Telephone, Telegraph and Radio	58	82
Railroad	70	127
Mechanical	89	126
Average	79	108

WILLIAM COLIN ROBINSON

The sudden death of William Colin Robinson, Vice-President and Chief Engineer of Underwriters' Laboratories, on Sunday, July 31st, at St. Luke's Hospital following an operation for appendicitis, removed from the fire protection and fire prevention engineering field one of its strongest men.

Mr. Robinson was a Cornell University graduate. Beginning as a sprinkler inspector for the Chicago Board of Fire Underwriters some twenty-eight years ago, he continued in this work until, in 1901, with the incorporation of Underwriters' Laboratories, he became associated with President W. H. Merrill and this institution. For twenty years he devoted his attention to problems of fire protection. He directed special interests to the protection departemnt of the Laboratories, and the high reputation for the thoroughness and accuracy of the engineering accomplishments of this institution was largely due to his painstaking labors and unusual ability.

He was 53 years of age, his acquaintance was wide and his friends were legion. Among engineering and other organizations in which he was active are: Western Society of Engineers, of which he had been a member since December 15, 1906; National Fire Protection Association, to which he belonged for 25 years, being Vice-President at the time of his death. He was a member of the Midlothian and South Shore Country Clubs and of the D. K. E. fraternity.

He leaves a widow and two sons, Paul and Hugh.

Interment took place at Oakwoods Cemetery, August 2, 1921.

W. LEE CAMPBELL

W. Lee Campbell, M. W. S. E., died May 29th, 1921. He was elected a member of the Western Society February 24, 1920, and was at the time of his death General Superintendent of the Automatic Electric Company, Chicago.

ADDRESSES WANTED

In order to have our records of members' addresses complete, we ask that anyone knowing the present address of members listed below to communicate with the Secretary.

Name.	Last Address Given.
James L. Anning	Rice Hotel, Houston, Texas
H. S. Baker	Wolcott, Ind.
B. H. Bryant	Apartado 46, Chichuahua, Mexico
D. H. Cahn	1004 Powers Bldg., Chicago, Ill.
Harold Cohn	168 W. North Ave., Chicago, Ill.
David Davis	5122 University Ace., Chicago, Ill.
H. W. Deakman	Lieutenant, 311th Engineers
Henry Fox	B. & O. Railway, Clarksburg, W. Va.
Roman de la Garza	10619 Longwood Drive, Chicago, Ill.
O. H. Gosswein	714½ Taylor St., Kokomo, Ind.
E. S. Herried	3229 Washington Blvd., Chicago, Ill.
W. Hess	4442 Dover St., Chicago, Ill.
H. F. Hill	Care of Chicago Telephone Co., Chicago, Ill.
Earl Hilton	5237 Ingleside Ave., Chicago, Ill.
Henry H. Hindshaw	Box 27, Hibbing, Minn.
Wm. B. Jackson	Room 1215, E. 123rd St., New York City, N. Y.
John Janicki	906 Maple Ave., Oak Park, Ill.
Joseph H. Kempster	443 E. 70th St., Chicago, Ill.
Armund M. Korsmo	1712 Montrose Ave., Chicago, Ill.
C. N. McNeil	1732 First National Bank Bldg., Chicago, Ill.
Miles H. Mann	Teetor Adding Machine Co., Des Moines, Ia.
T. R. Minert	1606 Hewitt Ave., Chicago, Ill.
Vincent Pagliarulo	628 Grace St., Chicago, Ill.
Roger C. Palmer	U. S. S. M. A. Barracks I, Champaign, Ill.
Louis A. Pettibone	Fon Du Lac, Wisconsin
Peter T. Priestley	6604 Loomis Blvd., Chicago, Ill.
Jerre T. Richards	1323 Emily St., Chicago, Ill.
F. Roberson	4432 Winchester Ave., Chicago, Ill.
T. H. Robertson	Dawson Springs, Kentucky
W. A. Robinson	6005 Prairie Ave., Chicago, Ill.
R. P. Sauerhering	269-608 S. Dearborn St., Chicago, Ill.
R. O. Scholz	921 Fifteenth St., Washington, D. C.
Frank H. Schwartz	4056 N. Lexington Ave., Chicago, Ill.
Chas. Shuman	24 W. Elm St., Chicago, Ill.
James Sorenson	511½ Cramer St., Milwaukee, Wis.
R. B. Stearns	245 State St., Boston, Mass.
John Stone	Aviation Corps, Ohio State University, Columbus, Ohio
James H. Ticknor	441 Magnolia Ave., Chicago, Ill.
Fred Weber	Care of Vacuum Oil Co., Detroit, Mich.
Edward Wilmann	1462 Avenue G, Flatbresh, Brooklyn, N. Y.
J. Kent Wilson	5432 Greenwood Ave., Chicago, Ill.

EXECUTIVE COMMITTEES

Chicago Sections of National Technical Societies

A. S. C. E.
(Illinois Section)
EXECUTIVE COMMITTEE
1921

Chairman..................C. B. BURDICK
First Vice-Chairman........A. J. HAMMOND
Second Vice-Chairman..........J. N. HATCH
Secretary-Treasurer..........W. D. GERBER
Trustee..............ALBERT F. REICHMAN

A. I. M. & M. E.
(Chicago Chapter)
EXECUTIVE COMMITTEE
1921

Chairman................LUTHER D. RICE
Vice-Chairman.........ARTHUR D. TERRELL
Secretary-Treasurer......FRANCIS G. FABIAN
HENRY W. NICHOLS WM. R. WRIGHT

A. S. M. E.
(Chicago Section)
EXECUTIVE COMMITTEE
1921

Chairman....................DAVID LOFTS
Vice-Chairman..........HORACE CARPENTER
Secretary...............J. D. CUNNINGHAM
J. C. PEEBLES FRANK R. WHEELER

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
(Chicago Section)
EXECUTIVE COMMITTEE
1921

Chairman..................M. M. FOWLER
Secretary......................E. H. BANGS
ERNEST LUNN C. A. KELLER
A. F. RIGGS W. F. SIMS
C. E. ALLEN

ILLUMINATING ENGINEERING SOCIETY
(Chicago Section)
EXECUTIVE COMMITTEE
1921

Chairman.................FRANK F. FOWLE
Managers
ALBERT SCHEIBLE J. J. KIRK
F. A. ROGERS LEE FARMER
J. H. ALLEN
Secretary.............ALBERT L. ARENBERG

ASSOCIATION OF IRON & STEEL ELECTRICAL ENGINEERS
(Chicago Chapter)
EXECUTIVE COMMITTEE
1921

Chairman....................JAS. L. MILLS
Past Chairman.................GORDON FOX
Local Secretary...........W. H. WILLIAMS
W. S. HALL C. W. DONOVAN
H. E. DAVIS

SOCIETY OF AUTOMOTIVE ENGINEERS
(Mid-West Section)
EXECUTIVE COMMITTEE
1921

Chairman..................B. S. PFEIFFER
Vice-Chairman.............GEO. T. BRIGGS
Secretary.............L. SPENCE SHELDRICH
Treasurer.............WALTER S. NATHAN

AMERICAN SOCIETY HEATING AND VENTILATING ENGINEERS
(Chicago Chapter)
BOARD OF GOVERNORS

President..................J. C. HORNUNG
Vice-President..............E. J. CLAFFEY
Treasurer.....................AUG. KEHM
Secretary....................BENJ. NELSON
JOHN HOWATT G. W. HUBBARD
FRANK VANINWEGER

MEMBERSHIP MATTERS

APPLICATIONS RECEIVED

Applications for membership were received by the Board of Direction since its meeting held June 20th, 1921, as follows:

55. Roland C. Rehm....................................1001 Otis Bldg., Chicago, Ill.
56. Herman Ritow..................................4306 Oakenwald Ave., Chicago, Ill.
57. Julius A. Folse (Transfer).........................Bov 245, Donaldsonville, Iowa
58. Dale Bumstead, Jr...................................504 N. East Ave., Oak Park, Ill.
59. Chas. E. De Leuw (Transfer).......................1206 Conway Bldg., Chicago, Ill.
60. Ross W. McKinstry (Transfer)......................1012 Kimball Bldg., Chicago, Ill.
61. Geo. W. Sproesser (Transfer)..........................Sioux Falls, South Oakota
62. Chas. Clarahan, Jr. (Transfer)..................336 Gazette Bldg., Little Rock, Ark.

Members are requested to communicate with the Secretary with regard to qualifications of the above applicants for membership in the Society.

EDGAR S. NETHERCUT,
Secretary.

ENGINEERING EMPLOYMENT

We wish to assist in placing valuable men in the employment most suited to them. Many concerns have positions open now or will have in the near future. What could be more logical than an engineering employer obtaining assistance from an engineering society, or an engineer looking for a position to seek a source that is in close tough with the engineering profession? You can co-operate by communicating with the Secretary's Office.

POSITIONS WANTED

B-1073: ENGINEER EXPERIENCED IIN DEsign construction and operation of machinery. Also in engineering faculty teaching applied mechanics, mechanical and structural design. Open for engagement.

B-1072: STRUCTURAL DESIGNER AND DEtailer familiar with reinforced concrete design, estimating and appraisal work seeks position. Experience, three years outside construction and four years on design and detailing.

B-1071: EXTRA WORK SATURDAY AFTERnoons and evenings, at your office or at home. Designing, detailing, computing, experimenting, cost accounting, special machinery, engines, plant layouts, production planning board records and reports. Experience, eight years.

B-1070: SALES ENGINEER IN ELECTRICAL field wants work in Chicago territory.

B-1069: INSPECTOR OF CONCRETE AND steel construction wishes connection with representative concern.

B-1068: PLANT CHIEF OR SUPERINTENDent with fifteen years' experience in installation of aerial and underground cable plants, also switchboard work on outside construction for telephone and power plants, open for position.

B-1067: ELECTRICAL ENGINEER, GRADUate 1918. Experience, one year, wiring, installing motors and switchboards in cement plant. Two years testing commercial electrical machinery, wants similar work.

B-1066: STRUCTURAL STEEL CHECKER—supervisor of high grade work, wants work in above field.

B-1065: ASSISTANT ENGINEER, CONTRACTor, construction valuation engineer or promotional and sales work in lumber industry, wants connection in similar work.

B-1064: POSITION DESIRED IN HARBOR engineering work, hydro-electrical plant, construction work or reinforced concrete work. Experience, five years, including harbor design and maintenance, river improvement and general surveying. B. S. in C. E. and Assoc. (N. Z.) Soc. C. E.

B-1063: POSITION DESIRED AS TEACHER in engineering, or in consulting engineer's office. B. S. in C. E. Iowa State and University of Wisconsin. Seven years' experience in hydraulic and sanitary engineering and research engineer in hydraulic engineering at University.

B-1062: REFINERY ENGINEER, NOW IN ENgineering department oil company, also three years Public Utilities Commission valuation work as inspector, one year testing department Commonwealth Edison Co., some experience in station operation summer vacations. University of Illinois B. S. in E. E. 1914.

B-1061: ADVERTISING MANAGER, TWO years engineer writer for Boston Transcript and leading magazines. Eight years with Clay Products Association, promoting and advertising. Two years Captain Engineers A. E. F.

B-1060: MANAGER CHEMICAL OR METALLURGICAL plant. Twenty years' experience from construction assistant to general superintendent of plant.

B-1059: DESIGNER AND ENGINEERING draftsman on special machinery. Six years' experience on automatic and hydraulic pumping machinery, structural steel and cereal plant, installation design.

B-1058: CLERICAL, GRADUATE OF CRANE Technical High School, with experience in filing records, keeping perpetual inventory, supplies, etc. Can operate typewriter.

B-1057: MAINTENANCE SUPERVISOR, GENeral engineering, drafting, Technical High School and College training. Married. Will leave city.

Engineering Employment, Continued

POSITIONS WANTED

B-1056: MECHANICAL DRAFTSMAN, TOOL designer, graduate M. E., also experienced in furniture design and architectural drawing.

B-1054: POSITION WANTED AS EXECUTIVE or assistant in industrial plant where methods of production can be developed.

B-1053: POSITION WANTED AS DRAFTSman, electric light and power layout, piping mechanical layouts, calculations checking. References.

B-1052: POSITION WANTED — INDUSTRIAL engineering, sales, or cost accounting. Taken full E. P. A. course. Over five years' experience on staffs of larger factories planning, production, control, time study, feeds and speeds, mechanical development of more economical methods of operating. Massachusetts Institute Technology, B. S. in M. E., 1917.

B-1051: GRADUATE ARMOUR INSTITUTE with electrical and mechanical experience desires position.

B-1050: ARCHITECTURAL AND CONSTRUCTION engineer, field and office experience. B. S. in Architectural Engineering 1917. Age 27 years. References.

B-1049: YOUNG ENGINEER WITH OIL REfinery, railroad, highway and building experience wants work in any of the above lines.

B-1048: GRADUATE ENGINEER WANTS POsition as experimental engineer. Experience in aerodynamical testing and experimental department of ventilating fan manufacturer.

B-1047: MECHANICAL DRAFTSMAN AND tracer with experience in coal handling machinery, grain elevators and railroad equipment wants work in above field.

B-1046: MECHANICAL ENGINEER WANTS A position in design or production, familiar with special machinery, also any phase of industrial work including time study and rate setting.

B-1045: SPECIAL MACHINERY DESIGNER, and designer of tools, jigs, fixtures and dies with experience in tool room and machine shop foreman to factory superintendent.

B-1044: WANTED—POSITION IN MACHINery sales, steel or metal products; designing or detailing—mechanical structural or plate work; or superintendent, expediter, inspector, layer out or templet maker.

B-1043: POSITION WANTED IN RAILWAY terminal work (field or office), engineer or superintendent, charge of construction. Experience ten years terminal work, studies, development of plans and construction.

B-1042: ARMOUR GRADUATE WANTS POSItion as construction inspector, assistant superintendent on construction or instrumentman.

B-1041: MECHANICAL DRAFTSMAN WITH editorial experience wants position in above field.

B-1040: MECHANICAL DRAFTSMAN WITH eight years' experience including shop inspecting and erection work wants work in drafting or shop inspecting.

B-1039: GRADUATE ELECTRICAL ENGINeer, six years as sales engineer and four years manager open for position as sales or district manager.

B-1038: MECHANICAL DRAFTSMAN WITH experience in ventilation and exhaust drafting wants similar work or can handle clerical position.

B-1037: CONSTRUCTION ENGINEER WITH experience on bridges, buildings, highways and railroads, also four years' designing steel and reinforced concrete wants work on construction or in office.

B-1035: DESIGNER OF STEEL AND REINforced concrete with twelve years' experience on steel mill buildings, factories, by-product plants and power houses wants work in above field.

B-1034: POSITION WANTED BY GRADUATE M. E. Illinois 1909 as draftsman, heavy machinery or instructor mechanical drawing or mathematics. Has had practical shop experience in structural steel and boilers.

B-1033: GRADUATE ENGINEER PURDUE '17 wants outside work on building construction as resident engineer or assistant superintendent.

B-1032: MECHANICAL-ELECTRICAL DRAFTSman with five years' experience in above, also designer of special machines, wants permanent connection.

B-1031: STRUCTURAL AND MECHANICAL designer with six years' experience open for work.

Engineering Employment, Continued

POSITIONS WANTED

B-1030: MECHANICAL ENGINEER WISHES work along power plant, maintenance, and fuel economizing lines. Can do drafting, structural or mechanical.

B-1028: FOREMAN OR SUPERINTENDENT construction wants work in above or as field engineer, general construction. Experience eight years.

B-1027: STRUCTURAL DESIGNER, STEEL and concrete, buildings and miscellaneous structures, open for work in above fields.

B-1025: SURVEYOR AND INSPECTOR, FAMILIAR with office work, wants work in reinforced concrete and steel construction.

B-1024: MECHANICAL DRAFTSMAN WITH three years' experience wants drafting or clerical work in engineering office.

B-1023: POSITION WANTED AS POWER plant, mechanical, or building designer.

B-1022: GRADUATE ENGINEER SEEKS work in mine or metallurgical plant. Prefers West.

B-1021: SUPERINTENDENT OF CONSTRUCTION open for such position. Can also handle position as maintenance superintendent.

B-1020: SALES ENGINEER DESIRES POSITION in selling or connection which will lead into sales work.

B-1019: STEEL DESIGNER AND DETAILER familiar with concrete design and architectural drawing open for engagement.

B-1018: POSITION WANTED AS CHIEF ENgineer, Chief Draftsman, Office Engineer, Sales or Contracting Engineer by engineer with fourteen years experience in steel, concrete and heavy machinery.

B-1016: POSITION WANTED AS STRUCTUral designer, building superintendent or estimator by engineer having wide experience in railroad and building construction.

B-1015: POSITION WANTED IN POWER House or Radio work. Experience in above fields.

B-1014: POSITION WANTED AS STRUCTUral designer or structural detailer by University of Illinois graduate, 1916.

B-1913: POSITION WANTED IN OR AROUND Chicago as assistant to municipal engineer, draftsman on municipal work or transitman on channel improvements or reclamation survey.

B-1012: ENERGETIC ENGINEER, UNIVERsity of Michigan graduate, desires to connect with engineering or manufacturing firm which may in the future be interested in development of sales of machinery or engineering project in Poland or Russia. Eight years' experience railroad construction, manufacturing and sales with leading U. S. A. concerns.

B-1010: POSITION WANTED IN CONCRETE design or assistant on concrete construction by graduate Purdue, 1921, having experience as chief of party on road survey.

B-1009: POSITION WANTED BY YUNIVERsity student in electrical engineering course. Prefers connection which will give him practical experience. Summer months only.

B-1008: POSITION WANTED IN DESIGN OF bridges or buildings by graduate Armour, 1921.

B-1007: EXECUTIVE WITH EXPERIENCE IN management corporations and consulting engineers who understands office routine, accounting purchasing, employment, visiting and directing field work, negotiating contracts and compiling engineering reports open for engagement.

B-1006: GRADUATE ELECTRICAL ENGIneer open for connection with good concern.

B-1004: WANTED POSITION AS DRAFTSman or tracer. Two years at Lane Technical High School.

B-1003: POSITION WANTED AS ASSISTANT engineer, manager of small plant or testing work on electrical apparatus. Willing to begin as apprentice.

B-1002: POSITION WANTED IN RAILROAD valuation or construction work. Familiar with making expert investigations.

B-1001: POSITION WANTED AS DESIGNER of dies, jig or tool work or on automatic stokers.

Engineering Employment, Continued

POSITION WANTED

B-1000: WANTED, TEMPORARY POSITION for summer only; railroad or industrial work.

B-999: POSITION WANTED IN RAILROAD valuation; experience seven years.

B-998: GRADUATE ENGINEER AND LAWyer wishes to connect with responsible company as engineer assistant to valuation counsel. Also would consider position as valuation engineer or engineer on construction.

B-997: POSITION WANTED IN SURVEYING or outdoor work.

B-996: POSITION WANTED AS GENERAL manager, works manager, or superintendent in research or development work along metal manufacturing lines.

B-995: MECHANICAL ENGINEER WITH EXperience on oil burning furnaces or allied industrial engineering problems; six years; open for engagement.

B-994: POSITION WANTED FOR SUMMER only in engineering office.

B-993: POSITION WANTED WITH CONSULTing engineering firm who specialize in power plant work.

B-991: POSITION WANTED AS SURVEYOR, steel designer or concrete inspector; experience two years.

B-990: POSITION WANTED IN MECHANIcal designing; tools, jigs, and fixtures, machine shop efficiency, or time study. Experience six years.

B-989: POSITION WANTED IN ELECTRIFIcation of railroads, power plant work or railway purchasing, by graduate Massachusetts Institute Technology, 1914.

B-988: POSITION WANTED IN CHECKING or detailing structural steel. Experience five years.

B-987: POSITION WANTED IN STRUCTUral or railroad engineering field by graduate Armour, 1919.

B-986: POSITION WANTED AS CONCRETE wood or steel engineer. Can take full charge of mill building.

B-985: POSITION WANTED AS INSTRUment man or rodman, on highway work.

B-984: CHIEF ENGINEER WHO HAS HAD charge of operation and maintenance of central station and industrial steam-electric power plants open for engagement. Experience twenty years. Good knowledge of boilers, stokers, turbines, condensors, feed water heaters, pumps, compressors and refrigerating systems.

B-983: POSITION WANTED IN POWER plant work, or engineering sales.

B-982: POSITION WANTED BY GRADUATE Mechanical Engineer, with experience as draftsman, designer, erection, production, maintenance and sale sengineer in executive capacity or sales engineering.

B-980: POSITION WANTED AS PRODUCTION, Industrial or Sales Engineer by graduate M. E. Armour, 1916. Experience four years, covering broad mechanical field.

B-979: POSITION WANTED IN SALES OR Office Work by graduate M. E. Michigan, 1900. Thirteen years in one position.

B-978: POSITION WANTED IN ELECTROmetallurgical plant using electric furnaces, or in small manufacturing plant where mechanical electrical experience can be utilized.

B-977: POSITION WANTED BY GRADUATE Electrical Engineer, Armour 1917, as equipment engineer or any position leading up to engineering sales.

B-976: POSITION WANTED IN THE ELECtrical field, Chicago or vicinity, by student who will be available during June, July and August.

B-974: POSITION WANTER IN POWER plant design or assistant to consulting engineer. Experience three years as above.

B-973: POSITION WANTED AS DRAFTSMAN, mechanical or electrical. Seven years experience including electrical operating work.

B-972: POSITION WANTED AS STRUCTUral draftsman. Experience five years.

Engineering Employment, Continued

POSITIONS WANTED

B-971: POSITION WANTED IN INSPECTION, supervision and reports on public utility properties or industrial plants. Principally mechanical engineering with possibility of application of electriacl. Experience broad, including five years consulting.

B-970: POSITION WANTER AS MECHANICAL draftsman or tracer. Experience six years.

B-969: POSITION WANTED AS CHIEF draftsman, designer, superintendent or estimator. Experience fourteen years including reinforced concrete, flat slab, structural steel and wood.

B-968: POSITION WANTED AS SURVEYOR or outdoor work.

B-967: POSITION WANTED DURING SUMMER in electrical drafting or testing.

B-966: POSITION WANTED AS DRAFTSMAN on special work and machinery during July and August. Experience six years. At present instructor mechanical engineering.

B-965: POSITION WANTED AS CONSTRUCTION engineer, assistant city engineer, or outside civil engineering work. Experience four years. Sewers, waterworks and on general construction.

B-964: POSITION WANTED AS COMBUSTION maintenance or power engineer. Experience twelve years.

B-963: POSITION WANTED AS CHIEF, OPERATING or maintenance, ice plant construction or operation, also electrical construction work. Experience sixteen years.

B-962: POSITION WANTED AS MECHANICAL draftsman, detailer or letterer. Experience in heating, plumbing, power plants and conveyors, foundries.

B-960: POSITION WANTED AS REFRIGERATION Engineer, executive in manufacturing plant or maintenance engineer in power plant.

B-959: POSITION WANTED AS DISTRICT highway engineer, superintendent on sewers, water, or municipal work. Experience twenty years as engineer in charge of construction, sewers, waters and paving work.

B-958: POSITION WANTED IN BUILDING design or ocnstruction by graduate architectural engineering course. At present employed away from Chicago but is looking for a local connection.

B-957: POSITION WANTED WITH CONSULTING engineer on municipal, water supply, sewage treatment or hydro-electric development work. Experience seven years in above fields.

B-956: POSITION WANTED AS MECHANICAL engineer or designer on bascule bridges, power plants, waste disposal plants and in general engineering work.

B-955: POSITION WANTED AS SUPERINTENDENT of construction, architectural or structural draftsman. Experience seven years.

B-954: POSITION WANTED AS ENGINEERING executive, or sales engineering, in good line or can invest with services in engineering company, architect or manufacturing concern.

B-953: POSITION WANTED IN HEATING, ventilating ,plumbing or electrical work. Experience also in mechanical equipment.

B-951: POSITION WANTED AS ENGINEER on concrete construction or sales engineer, railway equipment or supplies. Graduate engineer, 14 years' experience on railway construction, maintenance and water supply.

B-950: POSITION WANTED IN RAILROAD, Industrial or Highway Work. Experience, 17 years drafting, estimating, field and supervision, including resident and division engineer. What have you to offer?

B-949: POSITION WANTED BY GRADUATE C. E. having 20 years' experience office and outside work in roadway, construction, bridges, buildings, land valuations and contracts.

B-948: POSITION WANTED AS DESIGNER or production superintendent. Experience, 12 years in mechanical an d electrical fields. Would like to make connection where there is field for improvement of products or methods and developing new machines.

B-947: POSITION WANTED IN DRAFTING or tracing by young woman with three years' experience.

B-946: POSITION WANTED AS DRAFTSMAN on mechanical drawings and details—Civil, Electrical, Mechanical and Construction work. Also design and detail sof electrical apparatus

Engineering Employment, Continued

POSITIONS WANTED

B-945: POSITION WANTED AS ARCHITECTURAL draftsman or superintendent on building work. Experience, 18 years.

B-944: POSITION WANTED AS SALES ENGINEER, advertising or estimates on mechanical equipment or building products. Experience, 7 years.

B-943: EXTRA WORK SATURDAY AFTERNOONS and evenings, preferably to take home. Drawing and drafting, computing, designing, surveys. Map drafting, track layouts, structural detailing, checking. Experience, 10 years.

B-942: POSITION WANTED AS DESIGNER of steel structures, checker or squad foreman. Experience, 16 years. Prefer work in Chicago.

B-941: POSITION WANTED AS CONSTRUCTION inspector in Chicago.

B-940: POSITION WANTED AS CONSULTING or supervising engineer with Chicago concern. Prefer office work.

B-939: POSITION WANTED AS ENGINEER or superintendent on construction, maintenance, operation, or track elevation preferred. Experience, 6 years.

B-938: POSITION WANTED AS MECHANICAL draftsman on piping. Experience, 10 years as draftsman, designer, detailer and checker.

B-937: POSITION WANTED IN MECHANICAL of electrical engineering, plant evaluation or efficiency work. Nine years' experience.

B-936: POSITION WANTED—YOUNG MAN 21 years old. Experience, three years on heating and power plant equipment. Wishes work outdoors along mechanical lines.

B-935: POSITION WANTED AS STRUCTURAL designer. Familiar with concrete design. Experience in office and mill buildings, smelter structures, and theaters.

B-934: POSITION WANTED BY GRADUATE C. E. as superintendent of construction or on special investigations, making estimates and plans in connection with water and coaling stations.

B-933: POSITION WANTED AS WORKS maintenance engineer, office or sales engineer, mechanical. Can handle large ojbs as well as men and systems.

B-932: POSITION WANTED AS STRUCTURAL Engineer, field or office. Experience, 9 years.

B-931: POSITION WANTED IN DESIGNING, detailing, estimating steel and concrete, including coal tipples.

B-930: POSITION WANTER IN INDUSTRIAL engienering and management, illuminating engineering or electrical maintenance. Experience, 14 years as executive, electrical and mechanical engineer, drafting, accountant, statistician, designer, economist, plant construction an doperation.

B-929: POSITION WANTED AS ASSISTANT to factory superintendent or superintendent of construction (power plant work), or sales engineer, mechanical. Experience, 8 years in above work.

B-928: POSITION WANTED AS INSTRUMENTMAN or draftsman. Experience on R. R. track elevation work and valuation, drafting and designing on concrete work and concrete products plant.

B-927: POSITION WANTED AS ASSISTANT to vice-president, assistant to consulting engineer or sales engineer by gradaute M. E. Experience on inspection and building, also sales engineer, steam specialties for power plants.

SECRETARIES OF ENGINEERING SOCIETIES
CHICAGO, ILL.

Organization	Secretary	Address	Telephone
Am. Soc. C. E. (Illinois Section)	W. D. Gerber,	913 Chamber of Com.	Franklin 2243
A. S. M. E. (Chi. Section)	J. D. Cunningham,	2240 Diversey Blvd.	Armitage 254
A. I. E. E. (Chicago Section)	E. H. Bangs	Ill. Bell Tel. Co.	Off. 300
A. I. M. E.	F. G. Fabian,	1025 Peoples' Gas Bldg	Har. 470
Am. Ry. Engrg. Assn.	E. H. Fritch,	431 S. Dearborn St.	Har. 1069
Am. Chem. Soc.	S. L. Redman,	460 E. Ohio St.	Sup. 7920
Am. Soc. Htg. & Vent. Engrs.	Benj. Nelson,	1301 Monadnock Blk.	Wab. 9038
Am. Soc. Refrig. Engr.	Thos. McKee,	431 S. Dearborn St.	Har. 5643
Am. Steel Treaters Soc.	H. Blumberg,	Ill. Steel Co., S. Chgo.	S. Ch. 4000
Am. Inst. Architects	Ed H. Clark,	8 E. Huron St.	Sup. 1461
Assn. I. & S. Elec. Engrs.	W. H. Williams,	1501 Monadnock Blk.	Har. 1190
Am. Assn. of Engrs.	W. H. Dean,	29 S. LaSalle St.	Cent. 73
Am. Welding Soc.	L. B. Mackenzie,	608 S. Dearborn St.	Wab. 7134
Ill. Soc. of Architects	Ralph C. Harris,	192 N. State St.	Rand. 2409
Ill. Soc. of Engrs.	E. E. R. Tratman,	1570 Old Colony Bldg.	Har. 2196
Illuminating Eng. Soc.	Jas. J. Kirk,	72 W. Adams St.	Rand. 1280
Natl. Assn. Prac. Ref. Engrs. (Chgo. Sub.)	A. J. Plocinsky,	1505 S. St. Louis Ave.	Rand 6984
Soc. Automotive Engrs. (Mid-West Section)	L. S. Sheldrick,	910 S. Michigan Ave.	Har. 1455
Soc. Industrial Engrs.	Geo. C. Dent,	327 S. LaSalle St.	Wab. 3291
Struct. Engrs. Assn.	John P. Cowing,	30 N. LaSalle St.	Frank. 778
Swedish Eng. Soc. of Chicago	C. H. Mayer,	404 Monroe Bldg.	Rand. 6120
Western Society of Engineers	E. S. Nethercut,	1736 Monadnock Blk.	Har. 945

JOURNAL OF THE

WESTERN SOCIETY *of* ENGINEERS

Volume XXVI OCTOBER, 1921 Number 10

PROGRAM COMMITTEE

E. T. HOWSON, Chairman

The program for the 1921-22 season is now well launched. The meetings which have been held, up to the present time, have evidently met with the approval of the membership, for the attendance has exceeded that of the corresponding meetings in any previous year. The Program Committee is making every effort to maintain the standard for its programs which has been set by the September meetings and anticipates that its further efforts will meet with the same hearty reception by the membership.

While all of the details regarding some of the meetings which will be held in October have not been arranged for at this writing (September 19), the program for the six meetings which will be held this month are well in hand. Among those which are scheduled are the following:

GRAIN DUST EXPLOSIONS—OCTOBER 3

D. J. Price, grain dust explosion expert of the U. S. Department of Agriculture, will present a paper on grain dust explosion in which he will incorporate the results of the recent investigation of the Chicago & North Western elevator explosion in the Calumet district, Chicago. This will be the first public presentation of this information. He will also present moving pictures illustrating his paper. Mr. Price is the leading authority on this subject which is becoming of increasing importance to engineers and we are fortunate in being able to bring him before our Society.

AUTOMATIC SWITCHING OF TELEPHONE TOLL TRAFFIC—OCTOBER 6

Professor Arthur Bessey Smith, research engineer of the Automatic Electric Company, will present a paper on this increasingly important subject. While this paper will be of primary interest to telephone and telegraph engineers, it will also be of value to others interested in electrical communication.

THE WELLS STREET BRIDGE—OCTOBER 10

The engineering features of the Wells Street bridge now nearing completion will be presented by Mr. Thomas G. Pihlfeldt, Bridge Engineer of Chicago, and associates. This bridge, which carries the elevated on an upper deck, has attracted a great deal of attention because of the interesting problems encountered in its design and particularly because of the fact that it was erected under traffic and must be placed in service with the minimum amount of interruption to street and elevated railroad service.

GARBAGE DISPOSAL—OCTOBER 17

One of the most important problems confronting the city of Chicago at the present time is the disposal of its garbage. It is admitted that the present situation is unsatisfactory, but opinion is not so evenly divided regarding the proper means to employ. For this reason the essential features of the Chicago problem will be presented and the various solutions discussed in a series of papers on that subject.

STEINMETZ NIGHT—OCTOBER 20

The annual visit of Dr. Charles P. Steinmetz to Chicago has been a feature of the Western Society program for several years. We are again to be favored by this world renowned expert who will bring to us the latest thoughts from his fertile mind on the development of electricity and its application to industry in general.

SEPTEMBER 19th MEETING

Mr. Chas H. MacDowell, President of the Society, presided at the opening meeting for the season when A. R. Hirst, Chief Engineer of the Wisconsin Highway Commission, on Sept. 12, addressed the Society on the subject, "Developing a System of Highway Transportation to Serve the People of a State." Mr. MacDowell complimented Mr.

Hirst on the excellence of the Highway System in Wisconsin which is so largely the result of his direction since he became Chief Engineer in 1907.

Mr. Hirst is a very able speaker and handles his subject without fear of criticism. Necessarily as the servant of the public his work is dependent upon the requirements of the people. However, Mr. Hirst has fearlessly stood for sound engineering principles in the development of the highway system and has repelled the influences political and otherwise, that seek individual or class privileges in the development of highways. Mr. Hirst went into these features of highway planning and building to a considerable extent. His paper will be published in an early issue.

SEPTEMBER 10th MEETING

Mr. John P. Alvord, Past President, Western Society, presided at the meeting held September 19. This meeting was attended by about one hundred members and guests of the Society.

In introducing Mr. Arthur E. Morgan, Chief Engineer of the Miami Conservancy District, Mr. Alvord paid high compliment to the successful choice of the right man to care for this very extensive project. He stated that the success of this project was largely due to the ability of the Chief Engineer in building up a corps of engineers, whose experience and ability was such as to create public sentiment in their favor and carry out this project in an economical and successful manner. In addition to Mr. Morgan's wide experience as engineer, he has lately undertaken the matter of education and become president of the Antioch College. In this College he is developing new and progressive plans for engineering education.

Mr. Morgan called attention to the fact that experience in control of floods by dams, as applied to the lower Mississippi River, had raised question in the minds of a good many as to whether such a plan would be feasible in connection with the Dayton District. It was, therefore, necessary to call into consultation a Board of Engineers who would view this matter from an impartial standpoint and who would advise as to the best plan to be undertaken.

Mr. Morgan called attention to the fact that an engineer seldom has a chance to start and finish a project without hampering conditions. However, in this instance, the conditions were favorable and the project was carried through as planned. There are many obstacles which interfere in the proper completion of a project from an engineering standpoint—the finances, the legal questions, public opinions, all call for compromises. At Miami, however, no fundamental sacrifice was necessary. They had freedom to make expenditures for actual work and also make expenditures amounting to large sums where there was an ultimate economy. There was possible a very thorough preparation and due to the fact that public leaders had confidence in the engineering project, the public opinion was largely controlled. While the engineering project itself, as far as planning would have taken considerable time, there was necessary to precede the actual construction work by a considerable amount of legal attention, and as these difficulties were removed, the engineers were able to proceed with the engineering work. While the technical design is all important, it is only one of the necessary considerations.

Mr. Morgan said it is necessary to prepare a complete new legal code to meet this situation. This code was largely the work of the engineer and a complete study was made of all similar codes in the United States and Europe so that when the code was prepared by the engineers and whipped into shape by the lawyers, it was presented to the legislature in 1914 and passed by them without substantial change. It has not been necessary to amend this code in any wise. Plans prepared and the possibilities arranged for, were proper and broad enough to permit the completion of the work.

Mr. Morgan showed a number of slides illustrating the scope of the Miami Conservancy District's work; also showed slides indicating the extent of the disastrous flood, which called attention to the necessity of this large project. After the adjournment many of the audience remained to meet friends and make new acquaintances. Many spoke particularly regarding the high value of the meeting, the fine character of the address and the excellence of the slides shown.

YOUNG MEN'S FORUM

JOHN A. DAILEY, Chairman

The attendance at the opening meeting of the Young Men's Forum, held on Saturday afternoon, September 17, indicates a very successful year for this committee.

Mr. Chas. H. MacDowell, President of the Western Society of Engineers, met with the Forum and gave a very interesting talk on "Business Organization." In developing his subject he pointed out some of the obstacles that confront the engineers and showed how those obstacles can be overcome by determination and industry on the part of the individual. His talk was interesting and instructive.

In discussing the activities of the Forum Mr. MacDowell offered some very valuable suggestions, which the Forum will attempt to accomplish during the year.

The Young Men's Forum is rapidly developing into a real live adjunct of the Society. Our aim is to deal with business relations of the engineer and his influence in civic affairs. All members of the Western Society of Engineers are urgently requested to be recognized as members of the Forum and to take part in the discussion.

Our next meeting will be on Saturday afternoon, October 8, when Mr. Halbert P. Gillette, President and Editor of the Engineering & Contracting Publishing Company, will talk on "The Engineer as a Political Economist."

On October 22, Mr. Benj. Bills, General Sales Manager of the American Bond & Mortgage Company, will talk on "The Pursuit of Business."

American Institute of Electrical Engineers
CHICAGO SECTION

News of the A. I. E. E.

Those concerned in Chicago's transportation problem will be interested in inspecting the first of the new passenger coaches which have recently been put into suburban service by the Illinois Central Railroad. The cars are designed to meet the requirements of that glad day when electrification is a reality.

An effort is being made to obtain the use of the auditorium in the new Field Museum for those meetings of the Section for which an especially large attendance is anticipated. While this auditorium is not as centrally located as Fullerton Hall, it is easily accessible from the Roosevelt Road station of the elevated system, or the Wabash Avenue surface cars and it is particularly convenient for those who use the Illinois Central suburban service. The capacity of Fullerton Hall has been inadequate for the needs of the Section for some time and the new auditorium will afford an excellent meeting place for the larger gatherings.

A page is to be reserved in each issue of this Journal for the use of the Chicago Section of the A. I. E. E., and it is desired to occupy this space with current news of interest to the members of the local Section. The officers of the Section will make every effort to obtain such news but it is hoped that the members generally will assist them, as only in that way will it be possible to secure a sufficient amount of personal news matter. If you have news items of the character indicated, please communicate them to any official of the Section or send them to E. H. Bangs, Room 1701, 212 W. Washington St., Chicago.

Owing to the uncertainty of securing Dr. Steinmetz for one of his remarkable discussions before the Section this Fall, there has been some delay in issuing a complete program of the meetings for the coming season. However, all of the regular dates have been satisfactorily provided for and it is expected that a program will be announced shortly.

The Chicago Section is still growing and the following names were added to the membership list during the past month:

C. D. Bidwell, 1743 E. 68th St., Chicago.

William G. Dow, 6500 Ellis Ave., Chicago.

Rupert N. Early, 123 W .Madison St., Chicago.

Geo. J. Hollander, 541 Wrightwood Ave., Chicago.

Carl J. Koch, 3213 Warren Ave., Chicago.

Frederick C. Ryan, care of Signal Officer, 6th Corps Area, Ft. Sheridan, Ill.

Harold K. Weld, 1548 Conway Bldg, Chicago.

This is in the nature of an introduction to other members if any is needed.

Mr. A. E. Riggs, Chairman of the Transfer of Members Committee requests that attention be called to the work of this Committee, which is to facilitate the transfer of members from one grade of membership to another.

Undoubtedly there are those desiring to advance themselves in the grade of their membership and they are requested to communicate with Mr. Riggs, care of General Electric Company, 53 W. Jackson Blvd., Chicago.

The Committee on Increase in Membership is preparing for an active year in securing new members for the Institute in the Chicago district. Members of the Institute who know of live prospects are requested to forward their names and addresses together with any other pertinent information to the Chairman of this Committee—Mr. W. F. Sims, Commonwealth Edison Company, 72 W. Adams St., Chicago.

Welfare Committee. This Committee is a new departure for our local branch and as yet a complete schedule of activities has not been planned. If any of our members have suggestions to offer relative to the scope of the Committee's work, the Chairman would be very glad to receive them.

We believe that the present business depression has thrown a number of our members, particularly younger men, out of employment. If any of our members are out of employment, this Committee will gladly use its best efforts to find positions for such men if they will make their wants known to the Chairman.

No-Accident, No-Fire Week, October 8-14, 1921

The Chicago Safety Council will conduct a No-Accident No-Fire Week in Chicago, effective at 12:01 a. m., Saturday, October 8th, and concluding at 12 midnight, Friday, October 14th.

The Safety Council conducts its No-Accident No-Fire Week as a part of the Semi-Centennial Celebration of the Chicago fire which occurred on October 9th, 1871, and which latter celebration is in charge of the Chicago Association of Commerce.

During 1920 fatal accidents occurred in Chicago (including Cook County) at the rate of 1,982 per year, or 38 per week; fire waste occurred at the rate of $11,800,000 per year or $226,923 per week; serious injuries, involving disability of four weeks or more, occurred at the rate of 49,550 per year or 953 per week.

It is estimated by the Chicago Safety Council that the economic waste caused by accidents and fires in Chicago and its immediately contingous territory in 1920 amounted to $25,000,000. The humanitarian and civic aspects of this situation are of even greater importance.

Work and Be Worked

"It is more blessed to give than to receive," is a saying that all of us have heard and applied, but in giving our time to committee service in the organizations to which we belong, we very often find we are receiving more than we are giving. When there is so much to be done that is worth while that will advance the engineering profession to a regular place in civic counseis and make for general civic advancement it is queer that more engineers do not ask to be placed upon committees of the Western Society that are working along these lines.

Once an individual begins to help along with this work, he soon acquires an education along the lines being followed and then becomes an active producer toward bringing about the results sought. For the amount of work any individual puts into these things, his satisfaction in seeing the results, in seeing the growing activities and importance of the Society—these things compensate him many times.

In which field of committee activity are you interested?

Association of Iron and Steel Electrical Engineers

The fifteenth annual convention of this Association was held at the Hotel LaSalle in Chicago, September 19 to 21 inclusive. There was an attendance of about three hundred delegates. In connection with this convention there was an exhibit of apparatus, there being about fifty exhibitors altogether.

The papers presented at this convention were of a very practical nature and well received. Among the papers presented of especial import are the following:

"The Electrical Engineer in the Steel Plant and Out," by Mr. F. B. Crosby.

"Electrification of Steel Plant Railroads," R. B. Gerhardt.

"General Use of Oxygen in the Steel Mill Industry," E. A. W. Jefferies.

"Waste Heat Utilization for Steam Generation," G. R. McDermott.

The following officers were elected at this convention:

President—W. S. Hall, Electrical Superintendent, Illinois Steel Company, Chicago, Ill.

First Vice-President—R. B. Gerhardt, Electrical Superintendent, Bethlehem Steel Company, Sparrows Point, Md.

Second Vice-President—L. F. Galbraith, Electrical Superintendent, West Penn Steel Company, Brackenridge, Pa.

Treasurer—James Farrington, Electrical Superintendent, LaBelle Iron Works, Steubenville, Ohio.

Executive Secretary—John F. Kelly, 1007 Empire Building, Pittsburgh, Pa.

Twenty-Fourth Annual Convention American Mining Congress

The American Mining Congress will hold its convention in the Coliseum October 17-22, 1921. There will be at this conference representatives of the mining industries of the entire United States and delegates from foreign countries. In the Coliseum there will be shown an exhibit of the mining industry which will be very interesting to all engineers. From these exhibits of an educational nature, might be mentioned those of the Government of Alaska, States of Colorado, California, Utah and the Government of Mexico. There will be exhibits by the United States Bureau of Mines, Bureau of Forestry, Bureau of Forest Products, and Geological Survey.

There will be over thirty speakers of national reputation at this convention. Among the subjects which will be considered will be "Standardization," "Transportation," "Mechanical Equipment," in addition to the discussion of the progress of the industry. Mr. W. G. Loring of San Francisco is President and Mr. J. F. Galbreath, Executive Secretary.

PERSONAL NOTES

Major David E. Hannan, construction engineer, announces the removal of his offices to suite 705, 112 West Adams street, Chicago.

Mr. Henry Negstad has been appointed county highway superintendent for Brookings county, Brookings, S. D.

Mr. W. Scott Armstrong has just returned from a business trip to Cocula Tac, Mexico, in connection with valuation and construction work.

Mr. R. C. Meleney, who was formerly connected with N. Max Dunning, Architect, has become the Western Representative of Hart & Crouse Co., of Utica, N. Y., manufacturers of down draft smokeless boilers.

Major David E. Hannan, M. W S. E., formerly with the Engineer Corps and Tanks Corps, A. E. F., is a candidate for State Commander of the American Legion. The election will be held at the state convention at Decatur, Ill., October 10-11.

Mr. George B. Massey, of George B. Massey Company, Peoples Gas Building, Chicago, left on September 3 for an extended business trip through Europe and Asia lastting six months, in connection with some large projects in those countries.

Mr. P. S. Combs, former city engineer of Chicago, has been made liaison engineer between the city administration and the Union Station Company, which is relocating tracks, building viaducts and freight houses and will eventually construct the new union station.

Mr. Edward E. Haupt, President of the Strobel Steel Construction Company, is also president of the Building Construction and Employers' Association, and was required to do a considerable amount of work recently in connection with the building labor arbitration, for which Judge Landis was the umpire.

Mr. Arthur A. Morgan, formerly chief engineer of the Miami Conservancy District and now president of the Antioch College at Yellow Springs, Ohio, has been appointed chief engineer for the Pueblo (Colorado) Conservancy District project. Mr. Morgan spoke before the Western Society of Engineers on September 19th.

Mr. Chas. H. MacDowell, President of the Society, and President of the Armour Fertilizer Works, addressed the first meeting of the American Chemical Society, Chicago Section, September 23rd on the subject "Science and the Coming Agriculture," covering the services that chemistry and engineering may render to future generations in assuring them of an ample and well balanced food supply and also of sufficient clothing.

Mr. C. W. Place is the author of a paper in the August, 1921, issue of the American Society of Mechanical Engineers' journal on "Future Power Development in the Middle West." The author outlines a system for interconnecting fairly efficient steam power plants in one hundred odd cities of over 25,000 in fourteen middle-western states and installation of hydro-electric plants to carry peak loads. The advantages of the system are pointed out in the paper as well as the procedure to bring about its development.

Mr. L. K. Sherman was a speaker at the National Drainage Congress at St. Paul, Minnesota, September 22 to 24. Mr. Sherman, a director of the Congress, spoke on the subject, "Outlet Drainage Districts."

The Congress is an organization of land owners, engineers and contractors interested in the reclamation of swamp and overflowed lands. The members also consider means for the better protection of lands and cities from disastrous floods such as the recent ones in Pueblo and San Antonio.

Mr. Fred J. Postel, M. W. S. E., Supervising Engineer, Illinois Department of Public Works and Buildings, has resigned and returned to the consulting engineering practice as the head of F. J. Postel & Company, Chicago. Mr. Postel served four years in his State position. His Department has been consolidated with the architectural division. The work of the two offices is under the direction of the Supervising Architect, Edgar Martin, M. W. S. E.

Mr. A. Dryland, County Engineer, Middlesex, England, Past President of the British County Surveyor Society and a pioneer in the field of road tarring, was an attendant at the meeting of the Society held September 19. Mr. Dryland is making a trip through the United States and inspecting American road-building practice. His professional ex-

perience covers a period of forty years and he has been active in the development of highways in his native country. It was a pleasure to have Mr. Dryland at our meeting and his very appreciative words of the presentation of the paper of the evening by Mr. Arthur E. Morgan was indicative of his interest in American engineering practice.

Dean John F. Hayford, of the Engineering College of the Northwestern University, has been appointed by Chief Justice William H. Taft to serve on a commission to fix the boundary line between Panama and Costa Rica. In addition to Dean Hayford, Dean Ora Leland, of the Engineering College of the University of Minnesota, has been appointed on the commission; two other appointees remain to be named. Dean Hayford has served on several boundary commissions; the latest one being in 1912 in the same region. At that time the commission was engaged only in collecting maps which were submitted to the arbitrator, who was then Chief Justice White. This time a permanent boundary line will be formed.

WILLIAM M. McCARTNY

Mr. William McCartny, Engineer and Manager, the McCartny Realty Company, Youngstown, Ohio, died April 3, 1921. Mr. McCartny joined the Western Society of Engineers May 24, 1897.

NEWS NOTES

The Licensing Committee of the American Engineering Council held a hearing in the Auditorium of the Western Society Monday, Sept. 19, '21. Over 200 engineers constituents of member organizations had previously been invited to express their views, either in writing or in person. These engineers were carefully selected from among those who were known to be especially interested in the subject. Engineers in general were invited to the hearing. More information regarding the meeting will appear in the next issue of the Journal.

The American Association of Port Authorities meets in International Convention at Seattle, Washington, October 12-15. The Chicago, Milwaukee & St. Paul Railway is running a special "personally conducted" train to Seattle for delegates to the Convention, leaving Chicago on October 7.

The Louisiana Engineering Society, at New Orleans held its first Fall meeting September 12. A paper was presented by Mr. Walter Parker, entitled "The Economic Value of the Industrial Canal."

The American Society for Steel Treating have printed in their September, 1921, Transactions, a number of papers presented at the annual convention in Indianapolis, Sept. 19. This is the first anniversary of the amalgamation of the two societies devoted to this subject. The membership in the combined societies is now 3,200.

The American Institute of Electrical Engineers has scheduled a joint meeting for November 17 at New York with the Society of Naval Architects and Marine Engineers.

An Engineering Assembly authorized by special vote of the Executive Board of the American Engineering Council of the Federated American Engineering Societies will be held January, 1922, in conjunction with the annual meeting of the Council. The Assembly is planned for a three-day session, one day to be given to special meetings of the boards of member organizations and committees of the American Engineering Council, one day to the sessions of the American Engineering Council and at least one day to the discussion of some special topic, such as elimination of waste, licensing of engineers, the national department of public works or some other topic of importance to the engineering profession. The meeting will be held at Philadelphia.

The Forest Products Laboratory of the United States Department of Agriculture, Madison, Wisconsin, maintained in co-operation with the University of Wisconsin, announces the dates for the course of instruction in boxing and crating which will be given four times this year, as follows: November 7-12, 1921; January 9-14, 1922; March 6-11, 1922, and May 1-6, 1922. This course is essentially a practical demonstration of such points as the characteristics of different styles of boxes and crates, the importance of nailing, the advantages of using dense woods, the efficiency of metal straps, the effect of moisture and change of moisture conditions in lumber on the strength of boxes and crates, tests on wire bound boxes, methods of improving the design of fibre board boxes, and many other points of interest to the box and allied industries. During the year 1919, class 1 railroads alone expended $103,078,862 for lost and damaged freight. It is estimated that there is a loss of $500,000 per annum because of poor packing.

The Annual Convention of the American Mining Congress will be held in Chicago at the Coliseum, Oct. 17-22. Besides the General Convention sessions, there will be held conferences on National Standardization, National Oil Shales, and Public Education and Service.

The American Society of Civil Engineers has scheduled for Oct. 5, 1921, a meeting at which papers will be presented on the Flood

Problem, Water Power Development and Stream Control.

The American Society for Testing Materials has issued the 1921 Edition of its Book of A. S. T. M. Standards. The volume contains 890 pages and contains the 160 standards adopted by the society as follows: 61 on steel and wrought iron; 7 on pig and cast iron and fittings; 31 on non-ferrous metals; 18 on cement, lime, gypsum and clay products; 10 on preservative coatings and lubricants; 19 on road materials; 4 on coal and coke; 6 on timber and timber preservatives; 2 on rubber, and 2 on miscellaneous subjects. The price of the volume in cloth is $10.00. A volume will soon be on file in the Western Society library.

Two important meetings will be held in Chicago on Nov. 16-18. Engineers will find considerable advantage in attending the sessions of these two conferences and the members of the Western Society are invited to attend.

The Seventeenth Annual Convention of the American Civic Association and the Twenty-seventh Annual Meeting of the National Municipal League are scheduled for the week of Nov. 13 in Chicago. The American Civic Association was formed at a conference held in the City of St. Louis, June 9, 1904, by a merger of the American Park and Outdoor Art Association and the American League for Civic Improvement.

The meetings will be held at the Chicago City Club.

The American Gas Association meets in Convention at Chicago, Nov. 7-12 at the Auditorium Hotel. An exhibition of gas appliances, the largest in the history of the industry will be held in connection with the Convention.

Mr. Geo. H. Bennett, Engineer for the Chicago Plan Commission, is considered likely to be appointed Chief Engineer for the Chicago Zoning Commission.

The Utah Society of Engineers on Sept. 21st held a joint meeting with the A. I. E. E. J. T. Ellsworth, Superintendent of Zinc plants for the Judge Mining and Smelting Company, spoke on "The Production of Electrolytic Zinc."

FROM THE SECRETARY'S OFFICE

Edgar S. Nethercut, Secretary

Cantonment Construction

At the meeting of the Board of Direction held Sept. 20, 1921, the following report was approved and ordered published:

August 3, 1921.

Board of Direction,
Western Society of Engineers.

Pursuant to your request of July 18th in which you referred to us the report of the Public Affairs Committee of the Western Society of Engineers on the subject of "Cantonment Construction," we submit the following report and recommendation.

We believe that the findings in the report are correct and fair to all parties concerned. The report itself is voluminous, and probably it is not now of wide enough interest to warrant the expense of its publication. Nevertheless the report is important, and should be made available to all those who are interested. To accomplish this result we recommend that the following statement be printed in the Journal of the Society. This statement will inform the members of the Society of the interest that has been taken by the Public Affairs Committee and the Board of Direction in endeavoring to protect the fine record made in the work of the Construction Division by members of the Engineering Profession, many of whom were members of the Western Society of Engineers.

In 1919 a committee of the Congress of the United States was authorized to investigate Cantonment Construction. The investigation was conducted by Messrs. McKenzie, McCollough and Boremus, members of Congress, who made a report to Congress comprising some 3,000 pages of printed matter. This report bears date of April 1, 1920, and is known as the Graham Report on Cantonment Construction.

The investigation was conducted by open hearings, and was given wide newspaper publicity as it proceeded. The apparent unfairness and political motive of the investigation as reported by the newspapers attracted the attention of many of our members and Mr. Chas. B. Burdick, M. W. S. E., wrote a letter to the Board of Direction on April 13, 1920, suggesting that some action be taken to counteract the unfair statements and inferences that were being published broadcast as a result of the congressional investigation. Mr. Burdick's letter was referred to the Public Affairs Committee, which in turn edlegated the subject to Messrs. Robert Knight, M. W. S. E., Assistant Building Commissioner of the City of Chicago, and J. Frank Quilty, M. W. S. E., formerly Major Q. M. C., who served as a Constructing Quartermaster of the Construction Division of the army. The findings of this sub-committee have been approved by the Public Affairs Committee.

The sub-committee did not base its study on newspaper reports of the Graham Com-

mittee investigation, but sought and finally obtained a copy of the Graham report. This they analyzed thoroughly and also examined other sources of information. It has made a report comprising 36 typewritten pages reaching definite conclusions as shown herein.

The Graham investigation was directed as the following items:

(a). Was the so-called cost plus percentage form of contract used by the Construction Division a new, unwarranted and illegal departure?

(b). Under this form of contract was there labor inefficiency and material waste, and were such inefficiency and waste encouraged in order to increase total cost of work and consequent contractors' fees?

(c). Were exorbitant fees paid to contractors?

(d). Was there grafting—1: on the part of the contractors; 2: on the part of contractors' employes?

(e). Would the letting of contracts by the competitive bid system have been better practice, considering all the exigencies of the situation?

The evidence adduced by the Graham Committee was manifestly partisan and was obtained almost wholely from discharged laborers and from one contractor. The general conclusion of the Graham Committee was affirmative to all of the above questions.

The Public Affairs Committee reaches the conclusion that the proper answer to all of these questions is the negative. In reaching this conclusion it recognizes that there was inefficiency, probably about the same amount as is usual on work of such magnitude and such urgency, but believes that it was due to the general conditions prevailing and not to the form of contract. It also recognizes that there was some petty grafting on the part of contractors' employes, but not more than would occur on any work of like magnitude and that in all cases where detected it was promptly punished.

In contrast with the Graham Report, the Committee calls attention to the so-called Blossom Report. (War Department, Report of the Board of Review of Construction, to the Assistant Secretary of War, August 31, 1919.) The Blossom Report was made by the Board of Review of Construction appointed by the Secretary of War early in 1918 to investigate and report on all of the the construction work for the army made necessary by the war emergency. This Board consisted of Mr. Francis Blossom, a Civil Engineer of New York City, Mr. W. Sanders Davies, then President of the American Institute of Accounts, and Mr. Charles A. Morse, M. W. S. E. Chief Engineer, Chicago, Rock Island & Pacific Railroad, and at that time President of the American Railway Engineering Association.

This Board made a very thorough investigation extending over a period of approximately a year. Its members personally visited about 50 of the projects of the Construction Division and had access to and used the records of the Division in Washington and at various projects. The members of this Board are experts and well qualified for the work which they did.

The Board of Review, after investigations covering nearly a year, approved the work performed by the Construction Division throughout the war, both as to methods and results.

The Report of the Graham Committee, the Report of the Public Affairs Committee and of the Board of Review are available in the library of the Society, where they can be seen by any one who is interested in securing more detailed information on the subject.

As a matter of fairness, it is proper that the Western Society of Engineers should make this record of disapproval of such an unfair report as that of the Graham Committee, and at the same time express its commendation of the splendid achievements of the Construction Division under the leadership of General I. T. Littell, General R. C. Marshall, Jr., and the wonderful corps which they organized.

Respectfully submitted,
H. J. Burt,
C. A. Morse,
Special Committee.

Approved for publication by the Board of Direction of the Western Society of Engineers.

Edgar S. Nethercut, Sec'y.

Sept. 20, 1921.

Service on Committees

A member of one of our Committees remarked to the Secretary that it was a great pleasure for him to serve on the Committees of the Western Society of Engineers. He found that the Chairmen of the Committees were invariably men of considerable ability and experience and that their methods of conducting the committee deliberations were highly satisfactory and very beneficial to him in his progress in the engineering profession.

The comments of one of your members, as indicated above, are worthy of consideration by all members of the Society. The opportunity for members to give time and attention to the affairs of the Society and to the various activities of the Committees, is one of the great assets of Society membership. Benefits will be shown in proportion to the service, which the member renders.

It has also been suggested that those of our members who are in executive positions can greatly benefit the members of the Society

who are in a subordinate position by arranging as fully as possible an opportunity for the younger members to serve on Committees. Contact with the fellow members in this manner is very broadening in its effect and will reflect itself in the quality of the work that the younger men can do in their regular avocation. The upbuilding of the profession will be greatly enhanced by an enlargement of this opportunity for committee service. Acquaintances made in this manner are lasting and very beneficial to all.

Topographic Mapping of the United States

Under date of September 12, 1921, Mr. C. P. Birdseye, Secretary, Board of Surveys and Maps, of the Federal Government, addressed Mr. MacDowell, President, relative to the Temple Bill (House Bill No. 5230) now pending before Congress.

This bill provides for the completion of the Topographical Survey of the United States and outlines a program up to June 30, 1942, providing for a total expenditure of $37,-200,000. This subject has met the approval of many engineers and engineering societies. On April 25, 1919, a resolution was adopted by the Engineers, Architects and Contractors Conference on National Public Works held in Chicago, issued a very strong resolution in favor of this project. The American Society of Civil Engineers has likewise endorsed the bill.

The following resolution was adopted by the Board of Direction at its meeting September 20, 1921:

"WHEREAS, There was introduced in Congress a bill (H. B. 5230) providing for the completion of the topographical survey of the United States. And

"WHEREAS, The great importance of adequate topographical maps in the development of the natural resources of the country and the economic planning and construction of all kinds of engineering projects, is recognized by members of the engineering profession. And

"WHEREAS, the economic value of such a survey to public and private projects to be constructed during the next decade, will more than offset the expense of making standard topographical maps and will justify the necessary expenditure by Federal and State agencies in co-operation. Therefore

"RESOLVED, That the Board of Direction of the Western Society of Engineers endorse House Bill No. 5230, which provides for the completion of the topographic surves of the United States and urges its early consideration and passage. And that copies of this resolution be addressed to the members of Congress."

Quantity Survey and Payment For Estimating

The cost to the owner is increased by the method of taking estimates from a number of bidders figuring quantities separately and receiving no direct payment for the work involved. A report based on this practice, with recommendations calculated to eliminate waste in estimating, has been approved and adopted by the American Institute of Architects, the Associated General Contractors of America and the American Engineering Council of the Federated American Engineering Societies.

The report and recommendations follow:

PURPOSE OF REPORT.

The purpose of this report is to acquaint prospective owners and others financially interested in building and other construction projects with the wasteful duplication and consequent expense involved in the preparation of estimates of quantities under the systems now generally in vogue.

To ascertain the cost of a construction project it is necessary to determine and compile lists or estimates of the quantities of materials and work to be done, to which are applied a price for each item. Under existing methods this work is done separately by as many contractors as are permitted to bid, and there may be as many varying interpretations of a set of plans and specifications as there are bidders.

The recommended procedure of quantity surveying described herein is intended to eliminate the present wasteful and uneconomical methods by concentrating the function of determining and compiling the quantities and list of work involved in one agency for each project. This quantity survey to be submitted to all bidders with the plans and specifications.

TO OWNERS AND INVESTORS.

It should be realized that all expenses in connection with the planning of buildings and construction are paid by the owner. Those who contemplate building know that none can afford to work without fair compensation for services rendered but they probably do not realize that, due to practices in vogue, *they pay* for the cost of preparation of *all* bids, including that of the successful bidder. Generally speaking, it has been the practice to have the figures submitted by the successful bidder include an amount sufficient to cover the work entailed in making proposals on other work which he was not successful in securing; in short his "overhead" account is much larger than it necessarily should be—but for all this the owner pays. To eliminate the duplication of effort in estimating thereby reducing the contractor's overhead, with attendant reduction in the cost of building, re-

quires that all bids be submitted on the same basis and in such manner that they may be readily analyzed.

The owner should not be required to pay a contractor an overhead charge which includes any other costs than belong to his own project. It is believed that this can be accomplished by having made an itemized list of all quantities entering into the proposed work. The owner should pay for the preparation of this itemized list whether he proceeds with the building or not. It is obvious that such payment will be much less when such itemized list is furnished than otherwise, as each bidder is furnished with the list of quantities called Quantity Survey and each bidder is thereby released from the work of separately taking off the quantities from the drawings and specifications.

A quantity survey because it fixes definite quantities on which the bids are to be received eliminates speculation on the part of the bidders as to the quantities involved in the project and thus makes possible lower bids due to the elimination of this "contingency." Where the owner does not avail himself of the quantity survey procedure recommended herein he should pay for estimating work direct to selected bidders on a prearranged basis rather than have all his bids increased by an unknown amount for estimating quantities, which frequently in current practice the successful bidder distributes amongst the unsuccessful bidders in accordance with a pre-arrangement of the bidders.

TO ARCHITECRS AND ENGINEERS.

With the idea in view of having all contractors submit proposals on a uniform basis, with some means provided whereby the amount of the proposed work will not be left to individual interpretation of the plans and specifications, it seems most desirable that all owners through their architects or engineers should have submitted to bidders with the plans and specifications a so-called Quantity Survey. To insure the result aimed at, no proposals should be considered other than those based on the quantity survey accompanying the plans and specifications. It is therefore recommended to architects and engineers that, unless eliminated for some particular reason, all plans and specifications submitted to contractors for proposals be accompanied by a quantity survey. It is further recommended that the selected bidder shall submit, before the contract is awarded, a copy of the quantity survey with each item priced and separate items added for costs of administration, etc., the total to make up the bid price.

TO CONTRACTORS.

It is evident that before an intelligent proposal can be made upon and project, the contractor must have a quantity survey or some other statement of quantities involved. It has been customary in the past to add a stipulated overhead charge to provide for the cost of estimating and as this has been applied to every individual proposal made by the contractor, the successful bid, out of a possible fifteen or twenty, contains an item not strictly chargeable to such bid and thereby penalizes the owner. A quantity survey furnished to each bidder will reduce the cost of preparing proposals on prospective work and not only should but obviously will reduce each bid price and thereby directly lower the cost to the owner.

A quantity survey places all contractors on the same basis which is a definite one, from which they may price or determine the proper cost of the work. Each individual item or cost set out in such quantity survey should be a basis of determining the proper cost of extra work desired by the owner as well as a basis for credits on account of omissions; it also has the added advantage of enabling contractors to audit and prepare monthly statements, progress reports, etc.

RECOMMENDATIONS.

I. *Quantity Surveying.* Architects, engineers and contractors should jointly use their efforts to have established facilities for making quantity surveys.

II. *Payment for Quantity Surveying.* The owner should pay for the quantity survey from ¼ of 1% to 1% of the cost of the project for commercial and public work and not more than twice as much for residence work, whether the project is constructed or not.

III. *Cost of the Project.* The cost of the project may be defined as the accepted bid, or in cases where no bid is accepted, the bid of the lowest responsible bidder as determined by the architect or engineer. However, in cases where alternate bids are required, the additional payments for the quantity survey shall be based upon the additional quantities surveyed, as approved by the architect or engineer.

IV. *Altered Plans.* Altered plans which involve a change in quantities after the quantity survey has been made justify an addition to the original fee for quantity surveying.

V. *Basis of Contract.* Owners should have the option of: (a) Making the quantity survey a part of the contract, or (b) Permitting the successful bidder, at his own expense ,an opportunity to verify the accuracy and completeness of the quantity survey before the contract is signed. If he proves errors to exist in the quantity survey, the bidder shall be permitted to adjust his bid accordingly.

VI. *Unit Quantities and Standards.* The schedule of unit quantities should conform to

local customs or methods of measurement and should be so stated on the quantity survey. The eventual adoption of national standards is recommended.

VII. *Guarantee.* The guaranteeing of quantities by a Quantity Surveyor is not recommended, for it might influence the surveyor to protect himself by increasing the quantities. The extra cost of a guarantee would not be warranted.

VIII. *Existing Methods.* The cost to owners of preparing bids by existing methods, which make necessary wasteful duplication in estimating quantities by several bidders, is known to be much greater than the cost of preparing bids based on a quantity survey furnished by the owner, and therefore such existing methods are condemned and should be discontinued.

Civic Organizations In Chicago

Engineers have peculiar opportunities for public service. By training and experience they are well fitted to do constructive service to the community in these matters which have to do with health, safety and convenience of the citizen.

We have many civic organizations in the city, who under different names and forms of organization, have contributed to the progress of Chicago. Engineers as individuals have actively joined in the work of these bodies. Those who have been active are informed, but many of our members have only general information regarding these organizations and it is proposed to publish from time to time brief statements of the purposes and accomplishments of several of the more important groups, whose activities are broadly constructive in the affairs of the community at large.

The Western Society of Engineers is recognized as capable of participation in the civic progress of our city. The part that engineers may take in working with other civic organizations is a most vital part to any project for a public improvement, in affairs affecting health and general convenience of the public.

THE CHICAGO BUREAU OF EFFICIENCY.

Since its organization in 1910, the Bureau has issued some forty-three printed reports, dealing with a variety of subjects such as budget making, bond issues, purchasing of voting machines, street pavements and paving repairs, electrolysis, park administration, the water works system of Chicago, growing cost of election, excess condemnation, tax legislation, multiplicity of overlapping taxing bodies, unification of local government, constitutional and charter changes and the administration of various county offices.

The Bureau is "a citizen agency for promoting efficiency and economy in the organization and management of public business and for furnishing the public with exact information concerning the expenditure of taxpayers' money." It differs from other citizen organizations in that it concentrates upon questions of administration and the expenditure of public funds. The efforts of the Bureau have been directed to a solution of the problem which would result neither in crippling governmental activities, nor in placing an unnecessary burden upon the taxpayer.

MEMBERSHIP MATTERS

APPLICATIONS RECEIVED

Applications presented to the Board of Direction September 20, 1921, and received since the last meeting:

No.	Name.	Address.
63.	Gordon Fox	645 Peoples Gas Bldg., Chicago, Ill.
64.	Herman N. Simpson (Transfer)	6811 Emerald Ave., Chicago, Ill.
65.	Frank D. Danielson (Transfer)	Village Hall, Glencoe, Ill.
66.	Geo. E. Wolff	1240 Glenlake Ave., Chicago, Ill.
67.	Raymond J. Graham	213 N. 19th St., Louisville, Ky.
68.	Frank G. Welsh	2801 S. Michigan Ave., Chicago, Ill.
69.	Roy M. Singer (Transfer)	2325 N. Kedzie Blvd., Chicago, Ill.

Members are requested to communicate with the Secretary with regard to qualifications of the above applicants for membership in the Society.

EDGAR S. NETHERCUT,
Secretary.

The Building Labor Decision

Judge Landis, as Umpire of the building labor situation in Chicago, has made a decision that will help to remove the bad taste in the mouths of the public. The building labor situation in Chicago for years has been going from bad to worse. The policy of the unions was to adopt rules for each situation that would tend to produce a monopoly for its members. The policy of the building employers was to adopt rules to counteract each troublesome situation. The rules of both the unions and the employers tended to increase the cost of building and to cut down the number of building projects.

When Judge Landis agreed to act as umpire in settling the dispute and fixing wage rates, it was generally agreed that no commission could accomplish a satisfactory result. Judge Landis because of his character, vigor and his reputation for equity and public spirit, met with general approval.

Beginning in June he at once ordered the men back to work pending the negotiations which lasted three months. Then he began with the fundamentals. He desired to get the unions together on an agreement based on sound moral principles, which would be legal and would provide the community with labor organizations for building that would serve with least friction among themselves and deliver the best finished product at the least possible cost.

He succeeded in getting some 47 out of 52 unions together as signatories to what was termed the "uniform agreement," with the prospect that the unions still outstanding will come in by November.

The provisions written into the "uniform agreement," when carried out by the unions and employers, are bound to restore the confidence of the general public. Wise dollars will again seek investments in the products of this class of labor and work will be plentiful. The question of the amount of wage is relatively unimportant provided an equivalent amount of work is given. The unions know that Judge Landis has fixed a fair wage and will make such adjustments as will keep wages on a fair basis.

To engineers the decision is highly important; it permits the application of engineering efficiency methods in handling building work, it permits the use of equipment and materials which go toward reducing the total cost of work, and it will increase the total amount of work to be done. At the time of writing it appears that the wage reduction is unsettling the labor on some jobs that are in progress, but we venture to predict that the situation will settle down to a sane basis wherein the rank and file of labor will abide confidently in the decision, and that the building situation in Chicago will attain a stability which will augment the prosperity of the engineer, the contractor, the workman and the general public.

Believing that the text of the "uniform agreement" will be of interest and use to engineers it is printed in full as follows:

UNIFORM WORKING AGREEMENT

ARTICLE 1. This agreement, made this .... day of .... by and between ...., of Chicago, Ill., party of the first part, and the ...., of Chicago, Ill., party of the second part, for the purpose of preventing strikes and lockouts and facilitating a peaceful adjustment of all grievances and disputes which may from time to time arise between the employer and the employe in this trade and for the purpose of preventing other waste and unnecessary and avoidable expense, annoyances or delays, making building costs as low, stable and certain as possible consistent with fair wage rates and for the advancement of labor and management in skill and productivity.

2. WITNESSETH: That both parties hereby agree that there shall be no strikes, lockouts, or stoppages of work and that they will by lawful means compel their members to comply with the arbitration agreement and working rules as jointly agreed upon and adopted and that where a member or members affiliated with either of the two parties to this agreement refuse to do so, they shall be suspended from membership in the association or union to which they belong.

3. PRINCIPLES UPON WHICH THIS AGREEMENT IS BASED: Both parties hereto this day hereby adopt the following principles as an absolute basis for their joint agreement and working rules and to govern the action of the joint arbitration board as hereinafter provided for in all matters which may come before said board and any decision, agreements or working rules clauses in this agreement shall be null and void:

I. THAT THERE SHALL BE NO LIMITATIONS AS TO THE AMOUNT OF WORK A MAN SHALL PERFORM.

II. THAT THERE SHALL BE NO RESTRICTION OF THE USE OF MACHINERY, TOOLS OR APPLIANCES.

III. THAT THERE SHALL BE NO RESTRICTION OF THE USE OF ANY RAW OR MANUFACTURED MATERIAL, EXCEPT PRISON MADE.

IV. THAT NO PERSON SHALL HAVE THE RIGHT TO INTERFERE WITH WORKMEN DURING WORKING HOURS.

V. THAT THE USE OF APPRENTICES SHALL NOT BE PROHIBITED.

VI. THAT THE FOREMAN SHALL BE THE AGENT OF THE EMPLOYER.

VII. THAT WORKMEN ARE AT LIBERTY TO WORK FOR WHOMSOEVER THEY SEE FIT, but that they shall demand and receive the wages agreed upon by the Joint Arbitration Board in this trade under all circumstances.

VIII. The employers are at liberty to employ and discharge whomsoever they see fit.

4. ARBITRATION COMMITTEE: Both parties hereto agree that they will at their annual election each year select or elect an arbitration committee to serve for one year, or until their successors are elected and qualified. In case of death, expulsion, removal or disqualification of a member, or members of the arbitration committee, such vacancy shall be filled by the association or union, as the case may be, at its next regular meeting.

5. NUMBER OF MEMBERS: The arbitration committee for each of the two parties hereto shall consist of .... members, who shall, within thirty days after the completion and signing of this agreement, meet and form a Joint Arbitration Board, elect a President, Secretary, Treasurer and Umpire, and thereafter the said arbitration committee shall meet not later than the third Monday of January in each year in joint session, when they shall organize a Joint Arbitration Board for the ensuing year.

6. CLASSIFICATIONS OF MEMBERS OF THE ARBITRATION BOARD: No person who is not engaged in the trade covered by this agreement, or holds a public office, either elective or appointive, under the municipal, county, state or national government, shall be eligible to act as a representative in this trade joint arbitration board; and any member shall become disqualified to act as a member of this trade joint arbitration board, and cease to be a member thereof immediately upon his election or appointment to any public office or employment. This clause, however, may be waived by unanimous consent of the Joint Arbitration Board.

7. UMPIRE: An umpire shall be selected, who is in no wise affiliated with this trade, or who is occupying an elective public office. In the event of any umpire for any reason being unable to serve, any unsettled dispute within the jurisdiction of this agreement shall be settled by the Joint Conference Board, hereinafter referred to, and its decision shall be final and binding upon all parties to this agreement.

8. JOINT CONFERENCE BOARD: Both parties to this agreement hereby agree to recognize and abide by the decisions of the Joint Conference Board created under the terms of the joint agreement between the Building Construction Employers' Association of Chicago and the Chicago Building Trades Council, of which the parties to this agreement are members. Should a dispute arise between either party to this agreement and any other body of employers or employes and the parties in controversy are unable to adjust the same, said dispute will at once be taken up and decided by the Joint Conference Board, subject to appeal on all jurisdictional matters to the National Board for Jurisdictional Awards, whose decision and rules shall be final and binding upon all parties to this agreement.

9. POWER OF AWARD: The Joint Arbitration Board shall have full power to enforce this agreement entered into between the parties hereto, and to make and enforce all lawful working rules governing both parties. No strikes or lockouts shall be resorted to and work shall continue pending the decision of the Joint Arbitration Board, or the Joint Conference Board, or of the National Board for Jurisdictional Awards.

10. TIME OF MEETING: The Joint Arbitration Board shall meet upon forty-eight hours' notice to transact business, upon written request of either party hereto.

11. RULES OF PROCEDURE: When a dispute or grievance arises between a journeyman and his employer (parties hereto) the question at issue shall be submitted in writing to the president of the two organizations, and upon their failure to meet within forty-eight hours and agree and settle it, or, if one party to the dispute is dissatisfied with their decision, it shall then be submitted to the Joint Arbitration Board, which shall hear the evidence and decide in accordance therewith. All verdicts shall be decided by a majority vote, by secret ballot, be rendered in writing and be final and binding upon all parties. If the Joint Arbitration Board is unable to agree, the umpire shall be requested to sit with them, and after he has heard the evidence, shall cast the deciding vote. In the event of any dispute or grievance arising between officers, business agents or individual members of the party of the second part and their employers, party of the first part, their officials or individual members, for any cause whatsoever, there shall be no cessation or abandonment of the work on the part of either party to this agreement or any of its members, individually or collectively, but such grievance or dispute shall be settled as provided for in articles 2, 8 and 11 of this agreement.

12. POWER TO SUMMON MEMBERS: The Joint Arbitration Board has the right to summon any member or members affiliated with either party hereto against whom complaint is lodged for breaking this joint arbitration agreement or working rules, and also to appear as witness. The summons shall be handed to the President or Secretary of the association or union to which the member belongs, and he shall cause the member or members to be notified to appear before the Joint Arbitration Board on the date set. Failure to appear when notified, except (in the opinion of the board) valid excuse is given, shall subject a member to a fine of twenty-five dollars for the first default, fifty dollars for the second and suspension for the third.

13. The salary, if any, of a representative of the Joint Arbitration Board shall be paid by the association or union he represents.

14. STOPPAGE OF WORK AND PENALTIES: "No member, or members, affiliated with the party of the second part, shall leave his work because non-union men in some other line of work or trade are employed on the building or job, or because non-union men in other lines of work or trade are employed on any other building or job, or stop, or cause to be stopped, any work under construction for any member, or members, affiliated with the party of the first part except as provided in this agreement, under penalty of a fine of not more than $25.00.

Any member, or members, affiliated with the party of the first part, or officials or representatives affiliated with either of the parties hereto, violating any part of this agreement or working rules established by the Joint Arbitration Board shall be subject to a fine of $50.00 to $200.00. The fine shall be collected by the President of the association or union to which the offending member, or members, belong, and by him paid to the Treasurer of the Joint Arbitration Board not later than thirty days after date of levying said fine.

Nothing in this agreement shall interfere with the right of members of the party of the second part to refuse to work for members of the party of the first part when employed by any person or firm having building construction work done in Cook County by parties not affiliated with the party of the second part.

15. COLLECTION OF PENALTIES AND SUSPENSIONS: If the fine is not paid by the offender or offenders it shall be paid out of the treasury of the association or union to which the offender or offenders were members at the time the fine was levied against him or them, and within thirty days from date of levying same, or in lieu thereof, the association or union to which he or they belong, shall suspend the offender or offenders and officially certify such suspension to the Joint Arbitration Board within thirty days from the time of fining, and the Joint Arbitration Board shall cause a suspension decree to be read by the President of both the association and the union at their next regular meetings.

No one who has been suspended from membership in the association or union for neglect or refusal to abide by the decision of the Joint Arbitration Board may again be admitted to membership except by paying his fine or by unanimous consent of the Joint Arbitration Board. All fines assessed by the Joint Arbitration Board and collected during the year shall be equally divided between the two parties hereto by the Joint Arbitration Board at the last regular meeting in December.

16. QUORUM: Two-thirds of the members of the Joint Arbitration Board present (but not less than two of any one party) shall constitute a quorum of the Joint Arbitration Board, but the chairman of each of the two arbitration committees shall have the right to cast a vote in the Joint Arbitration Board for any absent member of his committee. However, in the event of no quorum, the matter in dispute shall immediately be referred to the Joint Conference Board, whose decision shall be final and binding upon parties hereto.

17. ABANDONMENT OF WORK: The abandonment of work by the individual members of the party of the second part, either separately or collectively, by concerted or separate action, on any building or buildings, being constructed by or for any member of the party of the first part, will be considered a breach of this agreement, unless the party of the second part, upon demand, furnishes within twenty-four hours an equal number of competent men for such work, and failing to do so, the rules and procedure governing the scarcity of help in this agreement shall be applicable in such cases.

18. SCARCITY OF HELP: If after forty-eight hours' notice to the party of the second part they are unable to furnish to all members of parties of the first part a required number of mechanics, then the party of the first part shall be entitled to procure and employ the men required. Such men shall be affiliated with international unions associated with parties of the second part. Failing after due notice of forty-eight hours to obtain mechanics so affiliated, the members of the party of the first part may employ such men as they may be able to procure, who shall by that fact be entitled to a permit to work, and the party of the second part shall immediately issue a permit to such men to work for such member of the party of the first part until such time as the party of the second part supplies sufficient men to take their places.

19. FOREMAN: The foreman, if any, shall be selected by and be the agent of the employer, subject only to the terms of this agreement and its working rules and decisions of the Joint Arbitration Board.

20. RIGHTS OF PRESIDENTS TO VISIT JOBS: The Presidents, or their authorized representatitves, carrying proper credentials, shall be allowed to visit jobs during working hours to interview the contractor or the men, but shall in no way hinder the progress of the work.

21. HANDLING OF TOOLS: The handling of all tools, etc., working machinery and appliances for the work covered by this agreement shall be done by members parties to this agreement and helpers in the trade, but nothing in this agreement shall prohibit a member of any other trade from using in his work, tools, machinery or appliances, similar to, or the same, as those customarily used in this trade.

22. HOLIDAYS: The following days (or days observed as such) shall be recognized as legal holidays: New Year's Day, Decoration Day, Fourth of July, Labor Day, Thanksgiving Day and Christmas Day. No work shall be done on these days except to protect life and property.

23. STEWARDS: If the men in this trade employed on a building or job desire to elect a steward from among their number, he shall be subject to the jurisdiction of the Joint Arbitration Board.

24. SMALL TASKS: Nothing in this agreement shall be construed to prohibit a journeyman or laborer of any trade from performing all small tasks of not to exceed a half hour's duration on any one day, ordinarily belonging to other journeymen or laborers, such other journeymen or laborers not being present on the building or job, at the discretion of the employer or foreman, in the interests of public economy.

25. OVERTIME: There shall be no overtime work except of an emergency nature to preserve life or property, at the discretion of the employer, subject to the jurisdiction of the Joint Arbitration Board, or except on the approval of the Joint Arbitration Board of this trade.

26. RIGHT TO STRIKE: Nothing in this agreement shall be construed to interfere with the rights of the officials of the unions from stopping work for the purpose of collecting wages due the members until such time as payment is made, or in case of dispute as to the amount of wages due, until the matter has been referred by one party or the other to the Joint Arbitration Board for adjustment.

27. UNAFFILIATED CONTRACTORS: Any contractor not affiliated with any employers' association party to this agreement may assume the benefits and obligations herein contained by joining the association, or upon signing this agreement and paying .... Dollars to the Joint Arbitration Board.

28. AFFILIATIONS: Both parties to this agreement hereby agree that they will not affiliate or connect themselves with any other body whose rules and by-laws, now or in the future, conflict with this agreement.

29. CONFLICTING RULES: No by-laws or working rules conflicting with this agreement shall be passed or enforced by either party hereto.

30. REPORTING OF ACCIDENTS: It shall be the duty of the foreman or steward, if any, to report personally both to the union and the contractor any accident which may occur on the work where they are employed.

31. JURISDICTION: The jurisdiction of this agreement shall include all territory within the County of Cook, Illinois.

32. TERMINATION OF AGREEMENT: It is agreed by both parties that this agreement shall remain in full force and effect from the date of same until May 31, 1923, except in respect to the rate of wages to be paid after May 31, 1922. It being understood and agreed that the umpire who by mutual agreement determined the prevailing rate of wages, shall on or before February 1, 1922, fix the rate for the unexpired period of the agreement.

WORKING RULES

HOURS: Eight hours shall constitute a day's work between the hours of 8 a. m. and 5 p. m., except on Saturday, when work shall stop at 12 o'clock noon.

WAGES: The rate of wages per hour during this agreement shall be .... payable in United States currency, or checks, at the option of the employer. Any member of the party of the first part, who fails to have sufficient funds in the bank to meet all pay checks issued to members of the party of the second part shall be penalized by the Joint Arbitration Board to the extent of a sum not less than the expense incurred in collecting the amount due, the full amount to be paid to the complainant as well as depriving the defaulting employer the right to pay by checks.

ADDRESSES WANTED

In order to have our records of members' addresses complete, we ask that anyone knowing the present address of members listed below to communicate with the Secretary.

Name.	Last Address Given.
James L. Anning	Rice Hotel, Houston, Texas
H. S. Baker	Wolcott, Ind.
B. H. Bryant	Apartado 46, Chichuahua, Mexico
D. H. Cahn	1004 Powers Bldg., Chicago, Ill.
Harold Cohn	168 W. North Ave., Chicago, Ill.
H. W. Deakman	Lieutenant, 311th Engineers
Henry Fox	B. & O. Railway, Clarksburg, W. Va.
Roman de la Garza	10619 Longwood Drive, Chicago, Ill.
E. S. Herried	3229 Washington Blvd., Chicago, Ill.
W. Hess	4442 Dover St., Chicago, Ill.
H. F. Hill	Care of Chicago Telephone Co., Chicago, Ill.
Earl Hilton	5237 Ingleside Ave., Chicago, Ill.
Wm. B. Jackson	Room 1215, E. 123rd St., New York City, N. Y.
John Janicki	906 Maple Ave., Oak Park, Ill.
Armund M. Korsmo	1712 Montrose Ave., Chicago, Ill.
C. N. McNeil	1732 First National Bank Bldg., Chicago, Ill.
Miles H. Mann	Teetor Adding Machine Co., Des Moines, Ia.
T. R. Minert	1606 Hewitt Ave., Chicago, Ill.
Vincent Pagliarulo	628 Grace St., Chicago, Ill.
Roger C. Palmer	U. S. S. M. A. Barracks I, Champaign, Ill.
Louis A. Pettibone	Fon Du Lac, Wisconsin
Peter T. Priestley	6604 Loomis Blvd., Chicago, Ill.
Jerre T. Richards	1323 Emily St., Chicago, Ill.
T. H. Robertson	Dawson Springs, Kentucky
W. A. Robinson	6005 Prairie Ave., Chicago, Ill.
R. P. Sauerhering	269-608 S. Dearborn St., Chicago, Ill.
R. O. Scholz	921 Fifteenth St., Washington, D. C.
Frank H. Schwartz	4056 N. Lexington Ave., Chicago, Ill.
Chas. Shuman	24 W. Elm St., Chicago, Ill.
James Sorenson	511½ Cramer St., Milwaukee, Wis.
John Stone	Aviation Corps, Ohio State University, Columbus, Ohio
James H. Ticknor	441 Magnolia Ave., Chicago, Ill.
Fred Weber	Care of Vacuum Oil Co., Detroit, Mich.
Edward Wilmann	1462 Avenue G, Flatbresh, Brooklyn, N. Y

ENGINEERING EMPLOYMENT

We wish to assist in placing valuable men in the employment most suited to them. Many concerns have positions open now or will have in the near future. What could be more logical than an engineering employer obtaining assistance from an engineering society, or an engineer looking for a position to seek a source that is in close tough with the engineering profession? You can co-operate by communicating with the Secretary's Office.

POSITIONS WANTED

B-1085: RESEARCH OR EXPERIMENTAL GAS or steam power, experience in railroad testing department on all kinds of material—iron, steel rails, tires. etc. Desire opportunity to learn steam and gas engine or turbine design.

B-1084: EXECUTIVE IN MANAGEMENT PRODUCTION or sales, particularly in mechanical engineering, experience on automotive construction and gas and oil power; also general design and construction in general machinery, small vessels, power plant work on gas units. Member S. A. E., Junior A. S. M. E., B. S. & M. E. University of Wisconsin, 1916.

B-1083: DESIRE POSITION IN THE MEchanical end of plant construction and design, or mechanical engineer in architect's office, or plant operator; six years manufacturing plant design and construction. M. W. S. E.; Member A. S. M. E.

B-1082: ENGINEER ON POWER AND INDUStrial plants, engineering design and construction, mechanical, electrical, civil; designing 9 years, construction 4 years, charge of work 5 years, executive 2 years.

B-1081: DESIGNING ENGINEER IN MECHANical and structural work. Member of American Society of Mechanical Engineers; chief draftsman in the design of heavy machinery. Would also consider position as sales engineer.

B-1080: DESIRES POSITION WITH CONSULTing engineer in electrical engineering or as electrical engineer for operating or manufacturing companies.

B-1079: METALLURGIST, NON---FERROUS; chemist, inorganic, analytical. Desires position where a sound technical training is desired. Graduate in metallurgical engineering.

B-1078: MINE ENGINEER OR GEOLOGIST, exploration or development, assayer and surveyor, three years experience examination and report, diamond drilling, surveys, etc. Member A. I. M. E.

B-1077: DESIGN, CONSTRUCTION AND OPeration of heavy machinery, also teaching structural and mechanical design; eighteen years' experience.

B-1076: FIVE YEARS' EXPERIENCE STRUCtural drafting and inspector of steel work in connection with tank construction.

B-1075: ELECTRICAL OR MECHANICAL ENgineer, experience in efficiency engineering, steam meters, electrolysis, special tests in power house work.

B-1074: ENGINEER OF CONSTRUCTION, preferably industrial; specification writer, architectural, appraisal work, buildings and structures. B. S. in civil engineering, 1905, Illinois.

B-1073: ENGINEER EXPERIENCED IN DEsign construction and operation of machinery. Also in engineering faculty teaching applied mechanics, mechanical and structural design. Open for engagement.

B-1072: STRUCTURAL DESIGNER AND DEtailer familiar with reinforced concrete design, estimating and appraisal work seeks position. Experience, three years outside construction and four years on design and detailing.

B-1071: EXTRA WORK SATURDAY AFTERnoons and evenings, at your office or at home. Designing, detailing, computing, experimenting, cost accounting, special machinery, engines, plant layouts, production planning board records and reports. Experience, eight years.

B-1070: SALES ENGINEER IN ELECTRICAL field wants work in Chicago territory.

B-1069: INSPECTOR OF CONCRETE AND steel construction wishes connection with representative concern.

B-1068: PLANT CHIEF OR SUPERINTENDent with fifteen years' experience in installation of aerial and underground cable plants, also switchboard work on outside construction for telephone and power plants, open for position.

B-1067: ELECTRICAL ENGINEER, GRADUate 1918. Experience, one year, wiring, installing motors and switchboards in cement plant. Two years testing commercial electrical machinery, wants similar work.

B-1066: STRUCTURAL STEEL CHECKER—supervisor of high grade work, wants work in above field.

B-1065: ASSISTANT ENGINEER, CONTRACTor, construction valuation engineer or promotional and sales work in lumber industry, wants connection in similar work.

B-1064: POSITION DESIRED IN HARBOR engineering work, hydro-electrical plant, construction work or reinforced concrete work. Experience, five years, including harbor design and maintenance, river improvement and general surveying. B. S. in C. E. and Assoc. (N. Z.) Soc. C. E.

B-1063: POSITION DESIRED AS TEACHER in engineering, or in consulting engineer's office. B. S. in C. E. Iowa State and University of Wisconsin. Seven years' experience in hydraulic and sanitary engineering and research engineer in hydraulic engineering at University.

Engineering Employment, Continued

POSITIONS WANTED

B-1062: REFINERY ENGINEER, NOW IN ENgineering department oil company, also three years Public Utilities Commission valuation work as inspector, one year testing department Commonwealth Edison Co., some experience in station operation summer vacations. University of Illinois B. S. in E. E. 1914.

B-1061: ADVERTISING MANAGER, TWO years engineer writer for Boston Transcript and leading magazines. Eight years with Clay Products Association, promoting and advertising. Two years Captain Engineers A. E. F.

B-1060: MANAGER CHEMICAL OR METALLURGICAL plant. Twenty years' experience from construction assistant to general superintendent of plant.

B-1059: DESIGNER AND ENGINEERING draftsman on special machinery. Six years' experience on automatic and hydraulic pumping machinery, structural steel and cereal plant, installation design.

B-1058: CLERICAL, GRADUATE OF CRANE Technical High School, with experience in filing records, keeping perpetual inventory, supplies, etc. Can operate typewriter.

B-1057: MAINTENANCE SUPERVISOR, GENeral engineering, drafting, Technical High School and College training. Married. Will leave city.

B-1056: MECHANICAL DRAFTSMAN, TOOL designer, graduate M. E., also experienced in furniture design and architectural drawing.

B-1054: POSITION WANTED AS EXECUTIVE or assistant in industrial plant where methods of production can be developed.

B-1053: POSITION WANTED AS DRAFTSman, electric light and power layout, piping mechanical layouts, calculations checking. References.

B-1052: POSITION WANTED — INDUSTRIAL engineering, sales, or cost accounting. Taken full E. P. A. course. Over five years' experience on staffs of larger factories planning, production, control, time study, feeds and speeds, mechanical development of more economical methods of operating. Massachusetts Institute Technology, B. S. in M. E., 1917.

B-1051: GRADUATE ARMOUR INSTITUTE with electrical and mechanical experience desires position.

B-1050: ARCHITECTURAL AND CONSTRUCtion engineer, field and office experience. B. S. in Architectural Engineering 1917. Age 27 years. References.

B-1049: YOUNG ENGINEER WITH OIL REfinery, railroad, highway and building experience wants work in any of the above lines.

B-1048: GRADUATE ENGINEER WANTS POsition as experimental engineer. Experience in aerodynamical testing and experimental department of ventilating fan manufacturer.

B-1047: MECHANICAL DRAFTSMAN AND tracer with experience in coal handling machinery, grain elevators and railroad equipment wants work in above field.

B-1046: MECHANICAL ENGINEER WANTS A position in design or production, familiar with special machinery, also any phase of industrial work including time study and rate setting.

B-1045: SPECIAL MACHINERY DESIGNER, and designer of tools, jigs, fixtures and dies with experience in tool room and machine shop foreman to factory superintendent.

B-1044: WANTED—POSITION IN MACHINery sales, steel or metal products; designing or detailing—mechanical structural or plate work; or superintendent, expediter, inspector, layer out or templet maker.

B-1043: POSITION WANTED IN RAILWAY terminal work (field or office), engineer or superintendent, charge of construction. Experience ten years terminal work, studies, development of plans and construction.

B-1042: ARMOUR GRADUATE WANTS POSItion as construction inspector, assistant superintendent on construction or instrumentman.

B-1041: MECHANICAL DRAFTSMAN WITH editorial experience wants position in above field.

B-1040: MECHANICAL DRAFTSMAN WITH eight years' experience including shop inspecting and erection work wants work in drafting or shop inspecting.

B-1039: GRADUATE ELECTRICAL ENGIneer, six years as sales engineer and four years manager open for position as sales or district manager.

B-1038: MECHANICAL DRAFTSMAN WITH experience in ventilation and exhaust drafting wants similar work or can handle clerical position.

B-1037: CONSTRUCTION ENGINEER WITH experience on bridges, buildings, highways and railroads, also four years' designing steel and reinforced concrete wants work on construction or in office.

B-1035: DESIGNER OF STEEL AND REINforced concrete with twelve years' experience on steel mill buildings, factories, by-product plants and power houses wants work in above field.

B-1034: POSITION WANTED BY GRADUATE M. E. Illinois 1909 as draftsman, heavy machinery or instructor mechanical drawing or mathematics. Has had practical shop experience in structural steel and boilers.

B-1033: GRADUATE ENGINEER PURDUE '17 wants outside work on building construction as resident engineer or assistant superintendent.

B-1032: MECHANICAL-ELECTRICAL DRAFTSman with five years' experience in above, also designer of special machines, wants permanent connection.

B-1031: STRUCTURAL AND MECHANICAL designer with six years' experience open for work.

B-1030: MECHANICAL ENGINEER WISHES work along power plant, maintenance, and fuel economizing lines. Can do drafting, structural or mechanical.

Engineering Employment, Continued

POSITIONS WANTED

B-1028: FOREMAN OR SUPERINTENDENT construction wants work in above or as field engineer, general construction. Experience eight years.

B-1027: STRUCTURAL DESIGNER, STEEL and concrete, buildings and miscellaneous structures, open for work in above fields.

B-1025: SURVEYOR AND INSPECTOR, FAmiliar with office work, wants work in reinforced concrete and steel construction.

B-1024: MECHANICAL DRAFTSMAN WITH three years' experience wants drafting or clerical work in engineering office.

B-1023: POSITION WANTED AS POWER plant, mechanical, or building designer.

B-1022: GRADUATE ENGINEER SEEKS work in mine or metallurgical plant. Prefers West.

B-1021: SUPERINTENDENT OF CONSTRUCtion open for such position. Can also handle position as maintenance superintendent.

B-1020: SALES ENGINEER DESIRES POSItion in selling or connection which will lead into sales work.

B-1019: STEEL DESIGNER AND DETAILER familiar with concrete design and architectural drawing open for engagement.

B-1018: POSITION WANTED AS CHIEF ENgineer, Chief Draftsman, Office Engineer, Sales or Contracting Engineer by engineer with fourteen years experience in steel, concrete and heavy machinery.

B-1016: POSITION WANTED AS STRUCTURAL designer, building superintendent or estimator by engineer having wide experience in railroad and building construction.

B-1015: POSITION WANTED IN POWER House or Radio work. Experience in above fields.

B-1014: POSITION WANTED AS STRUCTURAL designer or structural detailer by University of Illinois graduate, 1916.

B-1913: POSITION WANTED IN OR AROUND Chicago as assistant to municipal engineer, draftsman on municipal work or transitman on channel improvements or reclamation survey.

B-1012: ENERGETIC ENGINEER, UNIVERsity of Michigan graduate, desires to connect with engineering or manufacturing firm which may in the future be interested in development of sales of machinery or engineering project in Poland or Russia. Eight years' experience railroad construction, manufacturing and sales with leading U. S. A. concerns.

B-1010: POSITION WANTED IN CONCRETE design or assistant on concrete construction by graduate Purdue, 1921, having experience as chief of party on road survey.

B-1009: POSITION WANTED BY YUNIVERsity student in electrical engineering course. Prefers connection which will give him practical experience. Summer months only.

B-1008: POSITION WANTED IN DESIGN OF bridges or buildings by graduate Armour, 1921.

B-1007: EXECUTIVE WITH EXPERIENCE IN management corporations and consulting engineers who understands office routine, accounting purchasing, employment, visiting and directing field work, negotiating contracts and compiling engineering reports open for engagement.

B-1006: GRADUATE ELECTRICAL ENGIneer open for connection with good concern.

B-1004: WANTED POSITION AS DRAFTSman or tracer. Two years at Lane Technical High School.

B-1003: POSITION WANTED AS ASSISTANT engineer, manager of small plant or testing work on electrical apparatus. Willing to begin as apprentice.

B-1002: POSITION WANTED IN RAILROAD valuation or construction work. Familiar with making expert investigations.

B-1001: POSITION WANTED AS DESIGNER of dies, jig or tool work or on automatic stokers.

B-1000: WANTED, TEMPORARY POSITION for summer only; railroad or industrial work.

B-999: POSITION WANTED IN RAILROAD valuation; experience seven years.

B-998: GRADUATE ENGINEER AND LAWyer wishes to connect with responsible company as engineer assistant to valuation counsel. Also would consider position as valuation engineer or engineer on construction.

B-997: POSITION WANTED IN SURVEYING or outdoor work.

B-996: POSITION WANTED AS GENERAL manager, works manager, or superintendent in research or development work along metal manufacturing lines.

B-995: MECHANICAL ENGINEER WITH EXperience on oil burning furnaces or allied industrial engineering problems; six years; open for engagement.

B-994: POSITION WANTED FOR SUMMER only in engineering office.

B-993: POSITION WANTED WITH CONSULTing engineering firm who specialize in power plant work.

B-991: POSITION WANTED AS SURVEYOR, steel designer or concrete inspector; experience two years.

B-990: POSITION WANTED IN MECHANIcal designing; tools, jigs, and fixtures, machine shop efficiency, or time study. Experience six years.

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PROGRAM COMMITTEE

E. T. HOWSON, Chairman

November 7th Meeting—Illiana Harbor

On November 7th, Col. W. V. Judson, U. S. Engrs., Division Engr., N. W. Division, and District Engr., Chicago District, will present a paper to the Western Society on the subject, "Illiana Harbor." Col. Judson is the U. S. Engineer supervising the plans for this work of building a Harbor for deep draught ships in Wolf Lake, which lies adjacent to Lake Michigan on the line between Indiana and Illinois. This is part of a program for projected waterways connecting Chicago with the Gulf of Mexico and with the St. Lawrence River. Col. Judson will illustrate his paper with slides.

November 14th Meeting—Layout and Design of the Modern Industrial Plant

Industrial plant layout and design during the past few years of enormous factory expansion has developed into one of the most fascinating specializations in the science of engineering. The time existed, and within the memory of many of our members, when the "boss carpenter" built the factory from plans which embraced hardly more than the bounding dimensions of the structure and the machinery was placed where it would fit. Such methods may have been tolerable in the past, but they could not meet the urgent demands of the present for the utmost in economy and efficiency in manufacturing.

Mr. F. D. Chase, M. W. S. E., recognized throughout the country as one of the most progressive engineers, engaged in the location, layout, design, construction and equipment of industrial plants, is to present a paper on this subject.

November 18th Meeting—Engineering Features of Chicago's New Gas Plant

A very interesting program is provided for Nov. 18, when Mr. J. I. Thompson, Chief Engineer of the Koppers Company of Pittsburgh, Pennsylvania, will give a paper on the new gas plant which was put in operation in Chicago, October 21, 1921. This plant is one of the largest building projects undertaken in recent years in Chicago and it is quite likely that the Excursion Committee will later undertake to have the Society visit the plant. The plant occupies a 250-acre tract and has 12 miles of switch track. The plant has the most modern equipment for manufacturing coke-oven and carbureted water-gas for city use and supplies gas to a holder, having the largest steel tank in the world, and through a tunnel under the drainage canal, said to be the largest ever constructed for industrial purposes. The present plant can carbonize 2,000 tons of gas daily. All fuels are handled mechanically by modern methods.

November 21st Meeting—Experience Night

On November 21st there will be a joint meeting between the Western Society of Engineers and the American Society of Mechanical Engineers (Chicago Section). Speakers of the evening are the leading mechanical engineers in this section of the country. They are Capt. R. W. Hunt, P. W. Gates, H. C. Gardner and W. L. Abbott. The speakers have been asked to give reminiscenes of their personal engineering experiences or to present some phase of engineering development that will be helpful to the younger engineers.

November 30th Meeting—Illumination

This is a joint meeting of the Western Society of Engineers with the Mechanical Institute of Electrical Engineers (Chicago Section), the Illuminating Engineering Society (Chicago Section), and the Illinois Society of Architects at Fullerton Hall. "Illumination," by D'Arcy Ryan, Director of Illuminating Engineering Laboratory of the General Electric Company, at Schenectady, New York. His lecture will be illustrated by slides.

American Institute of Electrical Engineers
CHICAGO SECTION

The program for the meetings for this season has been arranged and the following is the announcement for the November meeting:

On Wednesday, November 30, at 7:30 P. M., there will be a joint meeting with the Western Society of Engineers, the Chicago Section of the Illuminating Engineering Society and the Chicago Section of the Illinois Society of Architects at Fullerton Hall. At this meeting a paper entitled "Illumination" will be presented by D'Arcy Ryan, Director of the Illuminating Engineering Laboratory of the General Electric Company at Schenectady, N. Y. Mr. Ryan's great success in connection with the Illumination of the San Francisco Exhibition and other exhibitions of a similar character has made him a person well-known outside of the electrical industry. To the members of the A. I. E. E. he needs no introduction. His lecture will be illustrated by means of a series of very unusual slides.

For the benefit of members who have recently moved to Chicago, it will be stated that Fullerton Hall is located in the Art Institute on Michigan Avenue at the end of Adams Street.

The following persons have recently applied for membership in the American Institute of Electrical Engineers:

Mr. Glen A. Barrer....1521 E. 65th St., Chicago, Ill.
Mr. Charles Matz....571 Hohman St., Hammond, Ind.
Mr. Hugo Jons....4758 W. Madison St., Chicago, Ill.

The following members have moved to Chicago:

Mr. Nelson S. Moore....3248 Carol Ave., Berwyn, Ill.
Mr. H. H. Adams....571 Hohman St., Hammond, Ind.
Mr. P. A. Robbins....280 Laurel Ave., Highland Park, Ill.
Mr. H. F. Pippenger....4647 Kenmore Ave., Chicago, Ill.
Mr. Alfred T. Jacobson....1508 N. Larrabee St., Chicago, Ill.
Mr. R. O. Herbig....2013 Fisher Bldg., 343 S. Dearborn St., Chicago, Ill.

The Welfare Committee under Mr. C. W. Pen Dell reports that it has succeeded in finding employment for several applicants from among those of the membership of the A. I. E. E. who have been temporarily unemployed. Mr. Pen Dell's address is 72 W. Adams St., Chicago, Ill.

A. S. M. E.

The November meeting of the American Society of Mechanical Engineers, Chicago Section, will be a joint one with the Western Society of Engineers, Mechanical Section, on November 21st, 1921. The subject will be "Engineering Experiences." The speakers will be:

Captain R. W. Hunt.
Mr. P. W. Gates.
Mr. H. C. Gardner.
Mr. W. L. Abbott.

The meeting will convene in the auditorium of the Western Society of Engineers in the Monadnock Building at 7:30 o'clock p. m. Moving pictures will be given at 7:00 o'clock p. m. Dinner will be served at the Chicago Engineers' Club to all those desiring it. The speeches will be limited to fifteen minutes and will be principally reminiscenes of early engineering experiences. The above speakers are all seasoned engineers and extremely well qualified to give very helpful suggestions to meet the present situation.

The first meeting of the Chicago Section of the American Society of Mechanical Engineers was held at the Chicago Engineers' Club on Monday, October 17th. Mr. Clark and Mr. Galusha of Dwight P. Robinson Co., of New York City, gave an illustrated lecture on the New Colfax Station of the Duquesne Light Company. Dinner was called promptly at 6:30 and one hundred and four members and guests sat down. Mr. Lofts, Chairman of the Chicago Section, opened the meeting and briefly outlined the activities of the Section for the coming year. He read the financial report of the Spring Meeting, which, it is believed, establishes a record for holding a large meeting at minimum cost. A total of $8,546.00 was received through members and non-members. The total expenses for the meeting were $2,471.78. The entire amount subscribed by non-members was returned and the balance sent back to the members prorated. Mr. Lofts then turned the meeting over to Mr. Bailey, who introduced the speakers of the evening. The lecture was met with hearty approval and very favorable comment.

A. S. M. & M. E.

On October 19 a luncheon was served by the Chicago Section of the American Society of Mining and Metallurgical Engineers, to welcome the out-of-town members who arrived for the American Mining Congress. Mr. F. K. Copeland acted as toastmaster and responses were made by Mr. C. H. MacDowell, President of the Western Society of Engineers; Mr. Edwin Ludlow, President A. S. M. & M. E., Mr. Wm. J. Loring, President of the American Mining Congress; Capt R. W. Hunt, Past President of the American Society of Mechanical Engineers, and Mr. R. S. Billings of Kingman, Arizona. The luncheon was served at the Blackstone Hotel and there were 158 present.

Young Men's Forum

On Saturday afternoon, October 8, Mr. A. E. White, President of the A. E. White & Company, Public Accountants, addressed the Forum on "Why the Engineer Should Have a Knowledge of Accounting."

The items found in the balance sheet, also the tentative system of keeping books and costs in a manufacturing plant, were some of the points touched upon and discussed.

These Forum meetings are open to members of the Western Society and their friends, and the attendance at the two meetings held this season proves that they are worth while. By attendance at these meetings the young engineer can widen his field of knowledge in the business work, thereby enabling him to prepare himself for executive capacity in some industrial enterprise.

From the large attendance at the meetings of the Young Men's Forum for this year, this branch of Society activity is having a very successful year's program.

On November 5, Mr. A. W. T. Ogilvie of the Swanson-Ogilvie Co., and a member of the Northwestern University faculty in the School of Commerce, will address the Forum on "Business Management."

The Quigley Furnace Specialties Company, Inc., of New York, announces that their pulverized feed department has been acquired by the Hardinge Company, New York. The Hardinge Company will make no change in the method of conducting the business at their offices, as the organization for the work has been acquired practically intact. The Quigley Furnace Specialties Company will devote their entire attention to their refractory specialties business.

Public Affairs Committee

The answers to the questionnaires strongly indicated the sentiment of the members of the Society in favor of participation in public affairs. Last year about forty of our members were enrolled with the Public Affairs Committee. In order that all of our members who wish to take active participation in this matter, an opportunity is now given to indicate your interest by a message to the Secretary, stating that you wish to be enrolled as a member of the Public Affairs Committee. You are urged to do this promptly, so that you will miss none of the meetings.

The Public Affairs Committee meets every Monday noon at the Chicago Engineers' Club, 314 Federal street, for lunch. The meetings are called together at 12:15 and adjournment is promptly at 2:00. Arrangements have been made with the Club, so that non-members of the Chicago Engineers' Club, attending this Committee meeting, may pay the cashier for their luncheons.

Call Harrison 945 and indicate your desire to enroll.

Suggested Research

The Engineering Foundation of the United Engineering Society, New York, advises in a recent circular of the suggested research regarding "Graphitic Corrosion" of Cast Iron:

"It has for years been known that some iron castings when long in contact with seawater, were so changed that they could readily be cut with a knife. Recently similar change has been observed in castings buried in soils impregnated with certain salts, especially in northern central United States and adjacent portions of Canada. Damage and danger result. Apparently this change has often been attributed to the action of stray electric currents from railways. Possibly the two kinds of corrosion have proceeded simultaneously in some places, and this fact has lead to failure to separate the two causes.

"A prominent engineer, who has studied the problem for several years with the assistance of experts, states that there is but little real knowledge concerning this phenomenon and has recently suggested a thorough research by Engineering Foundation because of the widespread interest in the problem to owners of water, gas and oil pipes, sea-going vessels, power plants and other industrial and engineering structures having iron objects exposed to salt or brackish water, or buried in impregnated soils. Lead is reported to have been similarly affected in some places. Engineering Foundation is making a preliminary examination of the subject, but needs a special fund of several thousand dollars to prosecute the research effectively."

A World Engineering Plan and Limitation of Armament

The world has been drifting along for some centuries under a so-called civilization made by human beings. Gradually and as necessity arose, laws and regulations, schemes and plans have been evolved to provide for the proper contact between individuals, organizations, communities, states and nations.

Plans for the development of cities to provide for growth have been evolved. Many cities are following such plans today. But no great plan has ever been suggested, as such, for the future growth of civilization. Nevertheless, civilization is growing, and with ever increasing frequence arise those problems between nations which must be solved.

What will be the future necessities of each and all countries in the world? How will each one grow and provide for these necessities? These are things which must be answered. They will be answered by an engineering plan used as a guide to world activities, or they will be answered by war.

But the next war, if the destructive schemes of the last are improved, will annihilate the human race. A gas has been developed that is heaver than air, has no odor, is invisible, and if it touches a living thing, will kill instantly. Whole populations can be destroyed overnight.

The United States Congress appropriations for 1920 were as follows:

Past Wars	$3.855,482,586	68%
Future Wars	1,424,138,677	25%
Civil Department	181,087,225	3%
Public Works	168,203,557	3%
Education & Science	57,093,661	1%
Total	$5,686,005,706	100%

In other words, if other governments are appropriating in like proportions then 93% of all governmental expenditures in the world is pure waste, and prevents world progress along sane and civilized lines.

One of the first steps in providing a plan or guide for world activities lies in the success of the coming "Conference for the Limitation of Armaments." In view of the figures on governmental appropriations above quoted and the fact that we are now the richest, most potential nation and yet have no designs, overt or unavowed on the possessions of prestige of any other country we should pray with all the religion that is in our hearts, that before the Conference is permitted to dissolve, a single firm first step be taken toward the security of international understanding.

The Chicago Fire and the Engineer

On the occasion of the fiftieth anniversary of the Chicago Fire, the relation between the Western Society of Engineers and Chicago's history is pertinent. Mr. Roswell B. Mason was mayor of Chicago at the time of the fire, having been elected November 2, 1869, for a two-year term. At the time of his election, he was President of the Civil Engineers' Society of the Northwest, the predecessor of the Western Society of Engineers. In the Chicago Evening Post of October 8th, a brief history of the life of Mr. Mason is set forth. After outlining his experiences as engineer in the early history of Chicago and the Middle West, it says:

"In 1867 in the position of chief engineer of the Dunleith and Dubuque Railroad, he finished the steel connecting link between the railroads of the great West. The bridge stands today as one of the monuments to his career.

"Roswell B. Mason was now to come to the most dramatic of his public service. Upon his return from Dubuque he found the government of Chicago in a bad situation. There were charges of corruption and incompetency, and a strong reform movement was under way. The press united with the best citizens in supporting a people's party to lead this fight. Col. Mason was nominated as mayor by the people's party and was elected November 2, 1869. Mayor Mason at once carried through to completion the Washington street tunnel under the Chicago River, a fact that was of great help to the community when the bridges were burned during the great fire."

It was during the great fire, however, that the test came, and here Mr. Mason, because of his executive ability and his wide experience in engineering, was able to fulfill the promises which led up to his election as mayor.

Mr. Mason lived to see the rebuilding of Chicago. Among the enterprises, which were developed by him may be mentioned: The development of Chicago as the great lumber market of the West and the transfer of the lumber business to the Twenty-second street district. He was also active in the street railway development of Chicago, having obtained the first franchise for horse-car line in the city and laid the first street car tracks on State street. Mr. Mason died January 1, 1892. He left as two more interesting monuments of his life the Western Society of Engineers, of which he was the first President, and the famous Presbyterian magazine, "The Interior," which he established as president of the publishing company.

PERSONAL NOTES

Taliaferro Milton has been elected Secretary of the Society of Automotive Engineers, Chicago.

C. R. Dart, M. W. S. E., has moved from 208 S. LaSalle street to Room 402, 6 N. Michigan avenue, Chicago.

Mr. Fred A. Hertwig, S. M. W. S. E., is now connected with the Iowa State Highway Commission at Garner, Iowa.

Edward O. Siegfried has taken a position with Clarence Hatzfeld, Architect, Tribune Bldg., Chicago.

Mr. Ernest V. Lippe, M. W. S. E., has joined the forces of the Haynes Company, Contractors, Engineers, Heating and Ventilating, 1933 W. Lake Street, Chicago.

Mr. Peter M. Larson, M. W. S. E., formerly with the Mutual Oil Company, of Chanute, Kansas, is now located in Chicago and is engaged in appraisal work.

A. W. Holmes, Assoc. M. W. S. E., of the Allen & Garcia Co., has left for Rosita, Coahuila, Mexico, where he will be engaged in engineering work in connection with coal mines of the Guggenheim interests.

Hubert E. Hudson, Assoc. M. W. S. E., has been appointed Assistant Chief Engineer of Sewers of the Board of Local Improvements, Chicago, succeeding Mr. Geo. C. D. Lenth.

Prof. Albert Smith, M. W. S. E., formerly Structural Engineer at the Purdue University, is giving a series of lectures at the Chicago Technical College, 116 S. Michigan avenue, on the subjects, "Wind Loads," "The Deflection of Beams" and "Secondary Stresses."

Mr. E. S. Volk, M. W. S. E., formerly connected with P. Nacey & Co., announces the establishment of a business under his name at 708 N. Carpenter St., Chicago. The company is engineer and contractor for the installation of automatic sprinklers; heating, ventilating and power work.

Mr. Wm. C. Potter, formerly of Dickman, MacKenzie & Potter, Engineers, Chicago, has been made President of the Guarantee Trust Co., New York. Mr. Potter is a young man and has progressed rapidly. He was for a number of years connected with the Guggenheim interests as a mining engineer.

Gen. Geo. W. Goethals, Hon. M. W. S. E., formerly Chief Engineer of the Panama Canal, is now in Mexico, where it is reported he is to be right-hand man to President Obregon. He is to become confidential advisor to the President in the execution of extensive series of works. The Mexican government is about to undertake the development of the resources of the country and the extension of its commerce and trade.

The account of the Chicago Fire recalls that William H. Musham, afterwards Fire Marshal of Chicago for many years, was in charge of the first fire engine to attack the Chicago fire. Mr. John W. Musham, M. W. S. E., is the son of William H. Musham. On November 19, 1902, Fire Marshal Musham presented a paper before the Society on the subject: "The Fire Extinguishment in Chicago." The same date Mr. E. B. Ellicot, M. W. S. E., presented a paper on "The Transmission of Fire Alarms."

Mr. H. J. Burt of Chicago, M. W. S. E., General Manager of Holabird & Roche, will supervise the work of planning and building the new memorial stadium for the University of Illinois. This stadium will cost about $2,000,000. The feature of the proposed plan is a three-deck arrangement for seats,—an idea which has never before been tried in American University stadiums. This plan enables the spectator to sit nearer the playing field and eliminates curved ends.

Mr. S. E. Bradt, Superintendent of Highways, Division of Highways, Illinois Department of Public Works and Buildings, has resigned after eight years' service. During this period the Good Roads Movement has been put on a sound financial basis, largely through the efforts of Mr. Bradt. Mr. Bradt has appeared before the Western Society of Engineers on numerous occasions and all who have heard him, have felt that his great activity in successfully planning the highway system for the State of Illinois, has been a large civic service.

NEWS NOTES

Nearly two hundred engineers attended the dinner to the delegation from the American Engineering Societies to Great Britain and France at the Hotel Pennsylvania of New York, Monday, October 10th. Representatives of the British and French Governments and of foreign engineering societies gave the affair an international aspect unique in gatherings of engineers. Medals struck by the French Government were presented to the General Chairman of the deputation, to the chairman of each individual delegation and to the Presidents of the four founder societies. The meeting was regarded by engineers as formally ushering in a definite movement for world unity in the engineering profession.

The speeches made by members of the deputation were descriptive of the delegation's experiences abroad and of the general conditions in France and England.

Following the death of Edmund T. Perkins of the Edmund T. Perkins Engineering Company, a new engineering company has been formed under the name of Randolph-Perkins Co., Engineers, at 1210 First National Bank Bldg., Chicago. This company is successor to and takes over the business heretofore held by the Edmund T. Perkins Engineering Company, Isham Randolph & Company and George B. Massey Company. The new company will conduct a general engineering business, specializing in land drainage, flood control, hydro-electric development, sewage disposal and water supply. The company will also act as managers and operators. The personnel of the new company is as follows: L. K. Sherman, President; Geo. B. Massey, Vice President; Robert Isham Randolph, Secretary, and Charles T. Mordock, Treasurer.

The 1922 Convention and Show of the American Road Builders' Association will be held at the Coliseum, Chicago, January 17-20, 1922. The enormous sums which have been appropriated for road building warrants the belief that the coming show will be even larger than the last.

The American Gas Association will hold its convention in Chicago, November 9 and 10, at the Congress Hotel. Some of the papers to be presented are, "Why Should Gas Companies Sell Their Tar to Distillers Instead of Working it Themselves," by R. P. Perry; "Selected and Annotated Bibliography on Gas Purification," by A. R. Powell and K. C. Walker; "The Seaboard Liquid Process of Gas Purification," by F. W. Sperr, Jr.; "Effect of Moisture on Activity and Capacity of Oxides for Gas Purification," by W. A. Dunkley; "What Goes on in a Water Gas Machine," by M. E. Benesh; "Some Experiments With the Mixing of Different Gravity Gases in Holders," by H. E. Bates, and "Utilization of Compressed Air in Clearing Gas Piping," by J. T. Griffin.

Illinois Engineers Inspection Trip

The senior students of the College of Engineering, University of Illinois, have recently made their annual inspection trip to Chicago. About 300 students altogether visited Chicago and were interested in the examples of engineering which were open to their inspection. Among the groups of the Engineering College were those of architecture; architectural engineering, electrical engineering, mechanical engineering, mining engineering; municipal and sanitary engineering, railway, civil and mechanical engineering, railway electrical engineering, and civil engineering. Excursions were taken for certain sections to Kenosha and Milwaukee. Among the points visited were the Northwestern Terra Cotta Company, Underwriters' Laboratory, Chicago & Northwestern Terminal Station, the Art Institute, the Lassig plant of the American Bridge Company, the Federal Reserve Bank, Field Museum, Illinois Steel Company, and the American Bridge at Gary, the Garbage Reduction Plant, the Chicago River and the Drainage Canal, Cook County Highway System, Western Electric Company, Lakeview Pumping Station, Evanston Filtration Plant, Chicago & Northwestern Railway Shops, and the Northwest Generating Station, Commonwealth Edison Company.

The Civil Engineers indulged in the social function on Friday evening, October 14, at the Fort Dearborn Hotel. A very excellent banquet was served, the arrangements being made by the members of the class.

Mr. C. S. Pillsbury, Albert Reichman, John Erickson and Edgar S. Nethercut, members of the Western Society of Engineers, were invited guests and greatly enjoyed the honor of meeting with this fine group of students. Mr. C. A. Ellis, formerly professor of structural engineering, University of Illinois, was also a guest.

It was remarked that this was the largest and finest looking senior civil engineering class that the University has ever produced. It might be remarked that, while Illinois is noted for its tall corn, it may well be noted for the tallness of the civil engineers. Nearly one-half of the class approaching very closely to six feet of stature. The management of the class is to be complimented on the fine arrangements which were made and the splendid spirit of service indicated by all the engineers visiting Chicago.

FROM THE SECRETARY'S OFFICE

Edgar S. Nethercut, Secretary

The Committees' Get Together Dinner

If anyone could have any doubt that the Western Society of Engineers is a power in the Central West, he should have attended the "Get Together Dinner" of the Committees at the Chicago Engineers' Club, September 30. There, each Committee Chairman of the twenty odd Committees, spoke from the heart on the plans, hopes and results of their work, both past and future, in a way which shows that the men responsible for the Society's activities, are instilled with the "service idea." They are interested in what they are doing, they are doing a big job and they are doing a big job well. Their aim is to increase the precedence of the Society in the minds of the public by service to the community and thereby to increase the precedence of the engineering profession and the individual engineer. President MacDowell emphasized the fact that as individuals we do not yet sufficiently realize the power actually wielded by the engineer at the present time and that the profession is gradually assuming a more responsible position in the business as well as the professional world. He took this gathering as an illustration of the need of engineers of Chicago for an engineers' building after the lines followed by our engineer friends in New York and Cleveland and predicted that the ever increasing interest and membership in the Society would soon bring active steps in this direction.

This dinner was the Annual Conference of the members of Committees of the Western Society of Engineers. It was planned so that the members of each Committee may know more of the work of the Society as a whole and may be better able to coordinate with the general plan. We have approximately 170 members of the Society on Committees. Membership on a Committee is to be greatly desired because of the natural benefit that comes through service.

Nearly one hundred men were present at the dinner, representing the four classifications of Committee activities. The first classification, the four Regular Committees, consist of the Finance, Mr. Niesz, Chairman; the Program and Publication, Mr. E. T. Howson, Chairman; the Library, Mr. I. F. Stern, Chairman; the Membership, Mr. E. W. Allen, Chairman, and the Committee on Amendments, Mr. C. B. Burdick, Chairman. Mr. Howson spoke interestingly of the work of his Committee, which has arranged in advance for a part of the year's program of about sixty technical meetings during the ten months from September to June, inclusive. The Committee is securing speakers on engineering subjects, which are of general and particular interest and which will draw a large attendance. Last year the attendance averaged a little over one hundred per meeting, but so far this year, the average attendance had been about 185 per meeting. Mr. Lacher, Chairman of the Sub-Committee on Publication, spoke of the twelve journals published each year in which we now run sixty-four pages per issue, 32 pages being allotted to technical articles and the balance allotted to advertising and Society news. It is a problem to include in the pages allowed the amount of material which is presented to the Society and to publish the information in a concise and neat form without wasting space. Altogether there are about 800 pages of material supplied per year as presented at the meetings, and it is necessary to arrange this material so that it can be included in the 384 pages allowed.

Mr. J. F. Stern thinks the Western Society library is one of the finest of its kind in this country.

He spoke with becoming modesty about the Library Committee. He told of the struggles of the Committee to place the library on a service basis, going into some detail as to the efforts of the Committee to obtain sufficient money to increase the library facilities. The attendance at the library and its use have increased so that it now has an attendance of some 1,500 persons per month. The library has approximately 12,000 volumes and pamphlets of special use to the engineer in his progress in the profession. Great progress has been accomplished in the work of the library during the past few years. It is maintained as a public library and its use is not confined to the members of the Society. Books are loaned out for any period, providing the user agrees to return them to the library when required.

Mr. Allen spoke briefly of the duties of the Membership Committee, which are provided specifically in the Constitution, for investigation of all applications for membership presented to the Board of Direction.

Mr. C. B. Burdick spoke of the work of the Amendment Committee, saying that the Constitution in some respects is too specific. The Constitution has had no revision since its adoption in 1911 and a number of rules have been provided by the Board of Direction, which should perhaps be included in the By-laws. There are numerous suggestions be-

fore the Committee, looking toward a revision of the Constitution and provision for By-laws of the Society.

A second classification of Committees of the Society are the Committees on Society Affairs, including the Development Committee, Mr. R. F. Schuchardt, Chairman; the Increase of Membership Committee, Mr. C. W. Pen Dell, Chairman; the Entertainment Committee, Mr. Geo. Waldo, Chairman; the Excursion Committee, Mr. W. O. Batchelder, Chairman; the Noon-Day Luncheon Committee, Mr. H. T. Walsh, Chairman; the Reception Committee, Mr. T. J. Ferrenz, Chairman; the Student Branch Committee, Mr. A. D. Bailey, Chairman and the Speakers' Bureau Committee, Mr. R. L. Morrell, Chairman.

During the last year the Development Committee was interested in ascertaining by means of a questionnaire the views of the members of the Society, relative to the possibilities of enlarging the Societies' activities. A Society that is growing and seeking to occupy as fully as possible, a special field, has need of the advice of such a Committee. This Committee can investigate the possibilities of increased activities of enlargement of the field, giving consideration to changes in our method of procedure to the great advantage of the Society. Mr. Schuchardt said that the Committee will aim to make the Society increasingly useful to fellow citizens as well as engineers.

Mr. Pen Dell on the Increase of Membership Committee explained that it was now necessary to launch a campaign on a different line than that which had recently been carried out. The former campaign for Increase of Membership was in the nature of a drive and the present effort of the Committee would be along other lines, more particularly, an effort to increase the membership of the Society by steady accretions. A careful estimate of the possibilities indicates that about 5,000 engineers in Chicago should be gathered together in this local society. It would be impossible to expect a rapid increase of our membership, except by again undertaking an intensive membership campaign. A very large and healthy growth can be secured, however, by paying attention to the natural desire of the engineer to be affiliated with his local engineering society.

Mr. Geo. Waldo, Chairman of the Entertainment Committee, is charged with the care of all entertainment and social affairs of the Society. A comprehensive plan of entertainment will greatly assist in increasing the acquaintance of members of the Society with each other in a way which cannot be accomplished by attendance at technical meetings. Great benefits can come, especially to our younger members, by a comprehensive program of this kind.

Mr. W. O. Batchelder of the Excursion Committee is glad to be in charge of the kind of excursions that the Western Society conducts, as they are intended to be useful trips, as well as trips for pleasure. Inspection trips to points of engineering interest in the vicinity of Chicago will be made; visits to industrial plants and to points where municipal development of the city are of interest to engineers.

Mr. H. T. Walsh is Chairman of one of the Noon-day Luncheon Committee, which has been brought to particular attention of the Society during the past year and its affairs have brought out some 400 on the average at Noon-day Luncheons. Many members are not so situated that they can conveniently attend evening meetings, and there are many speakers obtainable who are not qualified to address us from a technical standpoint, whose speeches would be full of inspiration and broadening in their character. The experience of the past year has been very satisfactory; and the work of this Committee is looked forward to with special interest.

Mr. Ferrenz of the Reception Committee said that his Committee expected to be present at all meetings, would endeavor to introduce members to each other and take care of strangers. He said that he expected his Committee to be of considerable assistance to the Membership Committee.

Mr. A. D. Bailey is Chairman of the Student Branch Committee. He said that his Committee was perhaps the only one that had been re-appointed in its entirety and that he could not understand the reason for this, except that during the past year they had been doing nothing but scrapping among themselves, and he thought the Secretary had figured out that this Committee did not know that the end of the year had come and that they might as well go on for another year. His Committee, he said, consisted of a half a dozen college professors, an editor, and himself. He could not understand why they had made the only man who had to work for a living Chairman of the Committee. This Committee made a careful study of the relations which should exist between the Western Society and the students in the technical colleges in the vicinity of Chicago. This is properly cared for as a distinct service on the part of the Society towards those who are about to enter the profession. The students are responsive to the activities of the Society and find great benefit from the relation as Student Members. As they progress in the profession, their relation with the Society is ordinarily maintained and their progress is noted as they advance from grade to grade.

As Chairman of the Speakers' Bureau Com-

mittee, the Society has a real find in Mr. R. L. Morrell. He is one of the Society four-minute men. In other words, the Speakers' Bureau Committee is one of the advertising departments of the Society. Wherever speakers on engineering subjects are desired, the Western Society aims to furnish men who can represent it or represent others in speaking on such subjects. The public press does not give the proper information in all respects. Through social and civic clubs, and societies, improvement associations, neighborhood clubs, there is a large opportunity for our members to present the engineering basis of public matters. Our Public Affairs Committee has carried on many important civic activities and recommendations have been presented. This Committee is charged with the duty of arranging for speakers to present to the citizens of Chicago, the findings of the Society on matters of municipal importance, and also those other engineering enterprises which involve the progress of the community, both industrial and commercial.

The third group of Committees of the Western Society is known as the Applied Technical Committees, which consist of the Waterways Committee, Mr. Murray Blanchard, Chairman; the Terminals Committee, Mr. E. J. Noonan, Chairman; the Aviation Committee, Mr. F. A. Sager, Chairman; the Building Committee, Mr. James N. Hatch, Chairman, and the Materials and Methods Committee, Mr. J. L. McConnell, Chairman. These Committees have to do with enterprises, which in their large aspect involve the combination of all the technical branches of the engineering profession. The object of these Applied Technical Committees is to bring together by informal discussions, investigations and reports, the engineers who are interested in large projects irrespective of their specialty. Among the particular projects which the Committee is to work on this year, Mr. Blanchard mentioned the Great Lakes and Lakes-to-Gulf Waterways.

Mr. Noonan, Chairman of the Terminals Committee, explained that there was little literature on Terminals as pertaining particularly to the relation between the public and railroads. Chicago being probably the greatest railroad terminal in the world, has been built up on competitive system and although many attempts have been made to simplify the terminal situation in Chicago, very little progress has been accomplished. When the terminals of Chicago are considered as a utility and their economic use is considered as of prime importance by the engineers of Chicago, constructive suggestions and recommendations can be made. Chicago's existing terminals must of necessity be the main consideration in any new plan. The problem is not necessarily, to build something new, but to correlate that which is already existing.

Mr. Hatch on the Building Committee said that it was their intention to take up the study of buildings as a utility rather than as a structure. Architects and engineers—structural, mechanical, electrical, heating and ventilating and industrial—each have their part to do in design and construction of their buildings. They seldom have the opportunity of knowing the effect of their particular part upon the use that the building is put to. By grouping together the engineers of Chicago, who are interested in the structural details of the building, with those managers of building properties and those interested in the maintenance of the buildings, so as to provide for an interchange of opinions and information, great benefit can come to all. A study should be made of the building code of Chicago, as well as the city requirements, as the sanitation and health. Reports by this Committee to the Society as a whole, will be very instructive. The members who actively engage in the work of this Committee will find that it will greatly broaden their information and increase their usefulness as engineers. This Committee will study the commercial and pleasure possibilities of aviation and its findings will be very interesting and enlightening to the membership at large.

Mr. McConnell, Chairman of the Materials and Methods Committee, explained that it was their purpose to study standards with the idea of making specifications that would reduce the cost of construction. In doing this, it would be necessary to co-operate with other associations of engineers, material men and contractors. This is a joint committee of the Illinois Chapter of the American Institute of Architects, the Illinois Society of Architects, the Structural Engineers' Association of Illinois and the Western Society of Engineers. This Committee has been in operation for the past two years and has given great consideration to the materials that enter into building construction and the methods that are employed in the erection of buildings. Specific recommendations have been made to the City Council relative to amendments to the building code. Looking towards increasing economy, possible in building construction, there has been a fine spirit of co-operation between the architects and engineers through this work, which is very beneficial to both professions.

The fourth and last group of Committees of the Society is the group of Committees on Special Activities, known as the Public Affairs Committee, F. K. Copeland Chairman; the Young Men's Forum, John Dailey, Chairman; and the Military Committee, D. D. Guilfoil, Chairman.

Mr. F. K. Copeland, Chairman of the Public Affairs Committee, was unable to be present. Engineers of the Western Society show an increasing interest in matters affecting civil life in Chicago. Believing that the engineer has special advantages because of his training and experience in molding public opinion, this Committee from time to time has taken up a consideration of matters affecting our municipal government, the Sanitary District, and the State government. The Committee offers a forum for the presentation of those things which affect the engineer in his profession, as well as those matters wherein the engineer is especially qualified to offer an opinion. The discussions have been quite free. Probably no activity of the Society has brought it more prominently before the people of Chicago than this Committee. Reports by this Committee, after approval by the Board of Direction, have been published throughout the city and have been accepted by the people at large for the benefit of the community. A close relation between the Public Affairs Committee and the Speakers' Bureau Committee will work to the advantage of the members and continue to extend the influence of the Society and of the members individually.

Mr. John Dailey, Chairman of the Young Men's Forum, is very enthusiastic over the progress made and the increased interest being manifested in the Young Men's Forum. The younger members of the Society have felt that great advantage could be made by meeting together and discussing in an informal way those things which have to do with their advance in the profession. It has provided Saturday afternoon meetings at which addresses have been given on many subjects related to the engineering profession; especially with reference to matters of business and administration, for which the engineer should be well qualified.

Mr. Guilfoil, Chairman of the Military Committee, spoke of the three things that the Committee intended to work on this year. First, standardization of military equipment; second, larger attendance at military engineering camps for civilians, and third, assistance in the formation of a National Guard regiment in Illinois. Mr. Guilfoil explained the need for the organization and the considerable length of time required for equipment and training. During the war this Committee was very active in assisting the Government, securing wherever possible engineers for military service. During the last year this Committee compiled a very extensive record of the activities of engineers of Illinois in the service of the Army and Navy. Engineers will be called upon to contribute very largely to the National Defense and the object of this Committee is to study progress of National Defense and the activities of Engineers in this important governmental service.

At the close of the meeting Mr. Harold Almert arose to call attention of the Society to the daily heading on one of Chicago's morning papers, giving a list of the six necessities in Chicago's civic program. This list is as follows:

Lessen the smoke horror.
Create a modern traction system.
Modernize the water department.
Build wide roads into the country.
Develop all railroad terminals.
Push the Chicago Plan.

Mr. Almert called attention to the fact that each and all of these subjects require the engineering profession to carry them out. Co-operation in the promotion of these things is only possible through organizations of engineers co-operating with other organizations in the community.

Report of the Development Committee

At a special meeting of the Board of Direction, held September 30, 1921, Mr. E. T. Howson, Chairman of the Development Committee for 1920-2921, presented the report dated August 31, 1921. On the completion of the discussion of the report, on motion of Mr. J. L. Hecht, seconded by Mr. Benj. B. Shapiro, the following resolution was approved:

"Resolved, That on recommendation of the Development Committee contained in their report dated August 31, 1921, be approved. That the specific recommendations be referred to the appropriate Committees. That the recommendations and analysis of replies be published in our Journal.

On motion of Mr. J. L. Hecht, seconded by Mr. Arn, the Board expressed its appreciation of the splendid work of the Development Committee in preparing the questionnaire. In analyzing the reports and in making specific recommendations to the Board to consider.

The report and recommendations are printed herewith for the information of the members. The careful thought which was given to the answers is indicative of the value of the suggestions from the members. Some comment and suggestions indicate that members do not know of some of the activities of the society. Further comment will be made by the Committee in charge in a subsequent Journal.

By order of the Board of Direction.

Edgar S. Nethercut, Secretary.

To the Board of Direction, Western Society of Engineers:

One of the activities of your Development Committee of last year was the preparation of a questionnaire relative to the present and proposed activities of our Society. This questionnaire was submitted to you with our recommendation that it be printed and sent to the members with the request that they fill it out and return it to the Society. You approved this recommendation and, acting under your instructions, the Secretary of the Society sent this questionnaire to all members. Approximately 380 replies were received which replies have been tabulated and analyzed. The results of this analysis form the subject of the following report which is presented to you as the final report of the Development Committee of the last administration, with such recommendations as appear to us to be justified by the expressions of opinion of the members.

MEETINGS.

Referred to Program and Publication Committee.

It is evident from the replies that the present hour for our General and Section meetings —7:00 p. m. on Mondays—meets with the approval of most of the members and we therefore recommend that it be retained. However, when it is necessary to hold more than one meeting a week, the replies indicate that Tuesday or Friday is preferred over Thursday, the evening now generally chosen. We recommend that this fact be brought to the attention of the Executive Committees of those Sections which are now meeting on other than Monday evening for their consideration.

It is evident from the replies to questions 3, 4, 5 and 6 that a dinner before the meetings at the Chicago Engineers' Club is favored by a number sufficient to warrant endeavoring to perfect arrangements for this service for members at the Club, table d'hote service of not to exceed $1.00 is preferred. We therefore recommend that negotiations with the Chicago Engineers' Club be undertaken promptly to endeavor to perfect such an arrangement for our members.

Only about one-third of the answers to questions 7, 8 and 9 indicate a desire for a smoker and buffet luncheon after meetings. In view of this note we do not consider it advisable to attempt anything along these lines at the present time.

It is evident from the answers to questions 10, 11 and 12, that monthly dinners of the Society meet with approval. This is also indicated by the success of the noon-day luncheons. In view of the vote of three to one in favor of monthly or quarterly dinners we recommend that the Board consider the feasibility of arranging for quarterly dinners or other social functions.

Apparently there is no necessity of increasing the number of general meetings of the Society as practically all of the answers to questions 13, 14 and 15, indicate that the present schedule of once a month is satisfactory. It is also evident that the members do not want Section meetings to the exclusion of the General meetings. By inference we therefore conclude that the present plan meets with the approval of the members.

The replies to question 16 indicate that joint meetings with civic and other technical organizations are favored by nearly all, but it is to be regretted that the question was not asked in such a manner as to indicate whether the desire was for joint meetings with civic organizations or with other technical societies.

PAPERS.

Referred to Program and Publication Committee.

Although some criticism of recent papers have been expressed verbally, it is evident from the replies received to question 1 to 5 that over 90 per cent of those answering stated that the papers presented within recent months have been of interest or service to the members, and furthermore, that they have been of sufficiently high standard and merit.

As indicated in the replies to questions 2, 3 and 4, a large number of the members naturally desire more papers on their specialties but these specialties are so numerous and diversified that the Society can hope to cover only a few in selecting programs. At the same time a majority of the answers to question 4 shows that papers on subjects outside of their own field are desired by members. Very little important information is disclosed by the answers to the question "What is your specialty?" These answers, typed on cards, have been classified according to the sections of the Society and should be reviewed by the Section Chairmen so that they may be guided in making up their programs and thereby please the majority of those who have been interested to the extent of sending in answers. Several have indicated their specialty as "Industrial Engineering."

The answers to question 6 are hardly conclusive so far as the choice of the character of papers is concerned, hence we conclude that papers of technical, descriptive or narrative character or of public interest, if of the proper grade, should appeal to the members.

The replies to questions 7, 8 and 9 indicate that the members desire to have papers presented in full rather than by abstract or by title, and furthermore, two out of every three

answers to question 8 show that the members want all papers and discussions published in full in the Journal. In answering question 9 opinions were about equally divided as to whether or not all papers and discussions should be published in abstract. We believe this subject warrants the serious consideration of the Publication Committee.

PUBLICATIONS.

Referred to Publication Sub-Committee.

The consolidation of the Bulletin and the Journal meets with the favor of members of a large majority, 347 to 34. This indicates the desire for fewer publications.

Out of 364 answers to question 2: "Do you keep files of the Journal?" 226, or 62 per cent say they do and 138 do not, but in 398 answers to question 3: "Do you bind the Journal?" 109, or 27 per cent, do and 289 do not.

A large majority, 285 out of 329 answers to question 4, say they read the Journal promptly. Out of 374 answers to question 5, 254 consult the advertising pages and 120 do not. Those objecting to the Society soliciting advertisements to defray the cost of publication are a very small minority, only 10 per cent or 38 in a total of 387 answering question 7. Out of 364 answers to question 8, 346 favor the publication of technical and engineering articles that have not been presented at Society meetings, but 206 of 382 answering question 9, do not favor expanding the Journal into a full-fledged engineering publication. Evidently the opinion is that certain carefully selected matter would add to the interest in the Journal but that to cover the entire field of engineering and business co-ordinated with it would be duplicating the present available publications.

It is felt that if increased interest could be developed for the Journal advertising space would become more valuable and advertising might be solicited more successfully.

SECTIONS.

Referred to Development Committee.

The subject of Sections, judging from the number of answers, does not appeal to the membership as greatly as some other features of the questionnaire. Only 154 answers were given to question 1, 71 for more and 81 for fewer technical sections. In response to question 2 suggestions are made for twenty-three additional Sections, and twenty-one combinations of present Sections have been suggested in reply to question 3. The variety of answers indicate a lack of urgent necessity for any changes and we suggest little change pending further study of the function and organization of activities of a local society which study we recommend be made.

There is a strong sentiment in favor of affiliation with local Sections of national societies; out of a total of 305 answers to question 4, 204 or 80 per cent are in favor of this procedure. We are heartily in accord with the majority on the policy and would further co-operation of this sort in every way possible. Fewer meetings with corresponding improvement in their character should result.

Out of 273 answers to question 5, 190 are not in favor of branches in nearby cities. Various places for meetings are mentioned from Peoria to Racine. In view of all circumstances we do not recommend that the Society extend its activities in this direction at present. Our meetings should be of such interest that out-of-town members will be willing to sacrifice time for the benefits assured.

There were 338 answers to question 7, the largest number to any question in this division, 267 or 80 per cent of which favor student branches. We recommend that an effort be made to enlist the co-operation of professors of engineering schools in the Chicago zone with a view of increasing interest in the Western Society among the students, the group that offers the best source of supply for future members.

COMMITTEES.

Referred to Development Committee.

Members, generally, passed over the question of whether there should be more or fewer committees—only 89 answered, of which 52 favored more committees and 37 fewer. Twenty-two different new committees were suggested in answer to question 2 and we refer these suggestions to the Board of Direction for consideration.

In reply to question 3, 171 indicated their willingness to serve on committees and 155 of these answered 4 regarding the most suitable time for committee meetings of whom 63 preferred the noon hour, 42 evenings (after 7:00 p. m.) and 23 had no choice of time and therefore could be counted with either of the afore-mentioned groups. Apparently the noon hour is most convenient for the majority of our members. Owing to the difficulty which many of our younger members encounter in absenting themselves from their work for a sufficient length of time to attend committee meetings at this hour, we recommend that an effort be made to secure the approval of employers to permit their attendance at such meetings. Certainly members offering to serve should be selected for committee work as far as possible and appointed to committee they prefer. Committee chairmen should be urged to add such mem-

bers to their committee wherever practicable and the time of meetings should be that hour most satisfactory to the members thereof.

A total of 219 out of 261 answers favor technical committees reporting annually on the advance in various branches of engineering and practice, some think more frequent reports should be made and others that Sections should make report for their special line of engineering. It is also suggested that many such reports would be duplicating work of national societies, whose reports are available in our library. We are inclined to accept this view and recommend that this policy be considered very carefully before adoption.

A total of 307 out of 327 members favor the appointment of special committees to investigate legislation affecting engineers and we recommend that this policy be continued and developed if practical. A total of 240 out of 301 members are in favor of initiating legislative action affecting engineers and this we also recommend as the policy of the Society.

QUARTERS.

Referred to the Special Building Committee to be appointed by the President.

It is very evident from the analysis of replies to questions 1, 2, 3 and 4 that the membership is very generally in favor of the establishment of an engineering building for the permanent home of the Society, with attempts to make the building self-supporting if possible and to secure at least a partial endowment, while at the same time selling bonds to the membership to assist in financing the remainder of the cost. The vote was 5 to 1 in favor of establishing such a building, 7 to 1 in favor of supporting it from rents or other commercial methods and approximately 4 to 1 in favor of attempting to secure at least a partial endowment, selling bonds to the membership, and in favor of purchasing some of the bonds individually. We therefore recommend that the Board of Direction keep this project continually before it with the purpose of undertaking it just as soon as conditions permit.

LIBRARY.

Referred to the Library Committee.

Approximately two-thirds of those replying use the library, the frequency ranging from weekly to yearly. Over 92 per cent favor continuing under the present policy. The vote on enlarging and improving the service was compartively low, but two-thirds of those voting favored such improvement, although the majority favoring such improvement at an increase in expenditure was comparatively small. The suggestion for improvement range all the way from the obvious one of adding to the number of books to charging for the service so as to raise a fund for research. Among other suggestions are the loaning of books, more detailed indexing, co-operation with the John Crerar library, keeping open evenings, establishing a bureau of information on engineering subjects, and providing better facilities for studious reading. Out of the total vote of 244, a majority of eight wanted the library kept open evenings, and some, in addition to every evening, wanted it open on Saturday and Sunday afternoons. Only one-fourth thought the library could be of greatest service by undertaking special work under a charge for this service, and a very small number desired additional periodicals. Out-of-town members suggested the following services for their benefit: Furnishing bibliographies, photostat service, information as to where articles or books on specific subjects can be obtained, providing a catalogue of publications on hand, and loaning books.

In view of the relatively limited expression of desire for more extended library service, and the present heavy expenditure for this purpose, we recommend that the service be not expanded except in response to very definite demands. We do, however, recommend that the Library Committee give serious consideration to this desire for the opening of the library evenings, particularly during the present period of widespread unemployment when those of our members out of work may desire to improve themselves by research.

CIVIC ACTIVITIES AND PUBLIC AFFAIRS.

Referred to Public Affairs Committee.

Sixty per cent of the vote of 302 felt that the Society does not participate sufficiently in local civic matters, and an overwhelming majority think that greater publicity concerning the Society's activities should be aimed at. The means suggested for this are co-operative action with other civic bodies, the obtaining of more notices and attention in general from the press, having more student branches, and inviting representative public men to our meetings.

Emphasis is placed on the Society taking a stand on all public questions of an engineering nature. The vote is almost unanimous in favor of informing the Society's members on the activities of the City Common Council, the State Legislature and the Sanitary District on matters concerning engineers. Almost as large a number favored a closer affiliation with the Chicago Association of Commerce and co-operation with municipal, county and state departments and bureaus. Nearly three-fourths of the 319 voting favored a Society branch or section on public affairs or civic matters. In view of the very evident interest in civic affairs, we

therefore recommend that the Board give serious consideration to ways of furthering Society activities in this direction.

INSPECTION TRIPS.

Referred to Excursion Committee.

More than 90 per cent of those replying to questions favored inspection trips through nearby plants and operations of technical or engineering interest. The Committee recommends: (1) that this means of instruction be continued; (2) that the list of 80 points of interest suggested by voting members be utilized; (3) that in the absence of a good reason to the contrary the trips be made on Saturday afternoons; (4) that trips be arranged for at approximately six-week intervals throughout the year excepting the months of June, July and August.

EMPLOYMENT.

Referred to Special Committee on Employment Service to be appointed by the President.

A large majority of those replying to the questions have expressed themselves in favor of continuing and expanding the present policy in connection with employment service which would mean the continuance of an employment bureau primarily for the use of members and those introduced by members. A large majority of those who made suggestions as to how the expense of expansion, if made, should be met, favor a suitable charge to those benefited by the service. The votes are equally divided on the question of whether a personnel officer be employed and whether the service should be limited to membership. The Committee recommends: (1) that the service be continued within the field of the membership of the Western Society, going outside only where the service will likely increase the membership and where approved by the Secretary; (2) that a personnel officer assigned exclusively to this work should not be necessary although a competent person on the regular staff should have a part of his time regularly assigned to this work and he should refer applications of members for more important positions to the Secretary; (3) that any additional expense caused by this service should be met by those receiving the benefit of it.

AFFILIATION AND CO-OPERATION.

Referred to Development Committee.

A large majority of those replying to these questions have expressed themselves in favor of such affiliation and co-operation with other engineering societies as will eliminate duplication of expense and at the same time co-ordinate the efforts of all.

The Committee recommends: (1) that the Western Society take active steps to canvas the situation with a view to consolidating offices of all national societies with those of the Western Society and at the same time arranging for joint officers and elimination of expense wherever practicable; (2) that the Western Society actively interest itself in the amalgamation of all national and local engineering societies of like standards or qualifications for membership with a view to eliminating expense, co-ordinating efforts and making the Chicago amalgamation as referred to in (1) above, an example which may later become the Chicago headquarters of a national engineering society patterned after the cosmopolitan advantage of Western Society and so including all engineers of similar qualifications.

Respectfully submitted,
E. T. Howson, Chairman.
J. E. Love.
W. A. Rogers.
G. R. Brandon.
H. S. Marshall.
R. F. Schuchardt.
Dabney H. Maury.

REPLIES TO QUESTIONNAIRE.

MEETINGS.

The Regular and most of the Section meetings are held on Monday night, with an occasional social meeting on one of the other nights.

Q. 1. If Monday is not satisfactory, give your preference in order: Yes. No.

A.

	1st	2nd.	3rd
Monday	56	8	8
Tuesday	30	13	5
Wednesday	10	6	8
Thursday	6	18	10
Friday	11	14	9
Saturday	—	1	4

Q. 2. What hour do you favor for evening meetings? 7:00, 236; 7:30, 91; 8:00, 35.

Q. 3. Would you care to take dinner at the Chicago Engineers' Club, service a la carte, before the meeting? 186 149

		Yes.	No.
Q. 4.	Ditto—table d'hote not to exceed $1.00?	214	113
Q. 5.	Same as No. 3, except at a Loop hotel or restaurant?	39	214
Q. 6.	Same as No. 4, except at a Loop hotel or restaurant?	54	207
Q. 7.	Do you favor a buffet lunch and smoker after the meetings?	124	214
Q. 8.	Are you in favor, as regards Question No. 7, of making a charge covering the cost to be paid by each member attending?	169	97
Q. 9.	If your answer to Question No. 8 is no, suggest a method of financing.		
A.	It should be a very light lunch not over 10 cents—a "coffee and sinker" effect; from general funds of the Society; per capita tax with yearly dues; pay as you eat; leave it to each one and avoid trouble; advance agreement (sent to members) that they will pay monthly bill for same.		
Q. 10.	Are you in favor of more meetings for social purposes?	186	136
Q. 11.	Do you favor monthly or quarterly dinners of the whole Society?	239	72
Q. 12.	When?		
Q. 13.	Do you favor more meetings of the Society as a whole?	92	238
Q. 14.	How often?		
A.	Monthly seems to be the preference of those who have answered this question.		
Q. 15.	Do you favor Section meetings only?	84	247
Q. 16.	Do you favor joint meetings with civic and other technical societies and organizations?	325	33

PAPERS.

		Yes.	No.
Q. 1.	Have papers presented in recent months covered topics of interest of service to you?	317	33
Q. 2.	Do you wish more papers on your specialty?	215	79
Q. 3.	What is your specialty?		
A.	As was to be expected, a wide variety of answers was received.		
Q. 4.	Do you wish more papers on subjects outside of your own field?	141	115
Q. 5.	Do you consider the papers in the past of sufficiently high standard and merit?	306	17
Q. 6.	Indicate your preference in order of the following classes of papers.....		
Q. 6a.	Dealing with highly technical problems and questions: A. 1st, 128; 2nd, 37; 3rd, 98.		
Q. 6b.	Of descriptive or narrative character: A. 1st, 115; 2nd, 89; 3rd, 68.		
Q. 6c.	Of public interest which particularly concern the engineer as a citizen: A. 1st, 105; 2nd, 130; 3rd, 39.		
Q. 7.	Indicate your preference in order of the following methods of presenting papers at meetings.		
Q. 7a.	In full: A. 1st, 164; 2nd, 51; 3rd, 18.		
Q. 7b.	By abstract: A. 1st, 48; 2nd, 79; 3rd, 3.		
Q. 7c.	By title only: A. 1st, 6; 2nd, 21; 3rd, 120.		
Q. 8.	Do you favor having all papers and discussions published in full in the Journal?	264	123
Q. 9.	Do you favor all papers and discussions published in abstract in the Journal?	158	148
Q. 10.	Have you in mind any subject matter which would make a paper of timely interest?	45	207
Q. 11.	If answer "yes" to Question 10, please write the Secretary.		

PUBLICATIONS.

The Society now expends about $12,000 annually on its Journal. This expense is but partly covered by the advertising revenue and the allowance from each member's dues of $2.00 for subscription. Recently the Bulletin or News Section has been consolidated with the Journal.

		Yes.	No.
Q. 1.	Is this plan preferable to the former separate publications?	347	34
Q. 2.	Do you keep your files of the Journal?	226	138
Q. 3.	Do you bind the Journal?	109	289
Q. 4.	Do you read the Journal promptly?	285	144
Q. 5.	What part do you read first?	75	61
Q. 6.	Do you consult the advertising pages?	254	120
Q. 7.	Do you favor the Society soliciting advertising to defray the cost of publishing the Journal?	349	38
Q. 8.	Do you favor the publication of technical or engineering articles and		

papers in the Journal which are not presented at Society meetings?......264 118

Q. 9. Do you favor expanding the Journal into a full-fledged technical periodical, with general news, personal items, editorials, new patents, manufacturing and industrial items, and trade activities?..................176 206

SECTIONS.

The Sections are separate organizations within the Society for the consideration of special problems and at present consist of the following: Mechanical; Electrical; Bridge and Structural; Hydraulic, Sanitary and Municipal; Gas; Railway, and Communication (Telephone, Telegraph and Radio) Sections. Joint meetings of these Sections with the local Sections of the national societies in like field are held frequently. The Section idea is a comparatively new one in the Society and the two last named Sections have been added only within the past year. Membership in any Section is open to all members of the Society without charge.

Yes. No.

Q. 1. Should there be more or fewer technical sections? A. More, 73; fewer, 81.

Q. 2. What other Sections do you desire?

A. Chemical; Industrial Management and Engineering; Ventilation; Refrigeration; Building Equipment; Safety Engineering; Economics and Finance; Building Superintendence and Construction; City Managers; Mining Metallurgy; Engineering Economy; Automotive; Military Engineering; Highway; Roads, Pavements and Contractors' Problems; Concrete.

Q. 4. Should the technical sections affiliate with the local section of the corresponding national society?..244 61

Q. 5. Do you favor local or geographical branches in nearby towns, not over 50 miles from Chicago?... 83 190

Q. 6. Where? A. Joliet, Kankakee, Chicago Heights, Indiana Harbor, South Chicago, Aurora, Gary, LaGrange, Kenosha, Waukegan, Racine, Peoria, Rock Island.

Q. 7. Do you favor student branches in nearby engineering colleges?..........267 71

COMMITTEES.

In the Journal you find a list of the present Committees, both standing and special. In nearly all cases the name of the committee is self-explanatory so far as their line of work is concerned except in the case of the Young Men's Forum. The Forum is really a branch of the Society, holding meetings on Saturday afternoons. The topics of the Forum meetings are diversified and appeal to the younger men, although all members and their guests are welcome.

Yes. No.

Q. 1. Do you favor more or fewer committees? A.: More, 52; fewer, 37.

Q. 2. Would you suggest any other committees? If so, name them. A.: Publicity; Exploiting and Selling the Engineer as an Asset, Not a Liability; Building Construction and Equipment; Urban Transportation; City Water Supply; Sanitation; Engineering Economy Contracts and Specifications; Engineering Education; Cost Accounting Sales Engineering; Building Code; Fire Prevention; Public Welfare; City Planning.

Q. 3. Are you willing to work on a Committee?

Q. 4. Give your preference. A.: (Information given to Committee on Committees.)

Q. 5. At what time of the day is it most convenient for you to attend committee meetings? A.: A variety of answers were received.

Q. 6. Do you favor technical committees to report annually on the various branches of engineering and practice?...............................219 42

Q. 7. Specify. A variety of answers were received.

Q. 8. Should the Society appoint Committees to investigate and report on such matters as the licensing of engineers and local and state-wide civil service for engineers, and to study local, state and national legislation affecting engineers?...307 20

Q. 9. Is it your idea that these Committees should initiate legislative action?..240 61

QUARTERS.

The Society has a lease on the present quarters, (recently enlarged) on the seventeenth floor of the Monadnock Block, expiring May 1, 1923.

		Yes.	No.
Q. 1.	Do you favor efforts to establish an engineering building as a permanent home for the Society?	301	63
Q. 2.	Do you favor attempts to make such a building a commercial proposition or self-supporting from rents?	286	36
Q. 3.	Do you favor attempts to secure at least a partial endowment for such a building?	237	67
Q. 4.	Should an effort be made to sell bonds to the membership to assist in financing such an undertaking?	240	62
Q. 5.	Without now pledging yourself to do so, would you consider purchasing some of the bonds?	217	68

LIBRARY.

The library of the Society is now under the supervision of an exceedingly competent librarian, who is in attendance during the day only. The large collection of technical books and current periodicals is being added to constantly, and a complete shelf index of the library is being compiled. The aim of the library is to furnish any technical information which a member may desire and to this end the librarian will list the books in which the information is to be found or will make a search through the various volumes. No service charge is made. The library is supported by an annual appropriation from the Society funds and by voluntary donations made by members. The reading room is open during the day and on meeting nights.

		Yes.	No.
Q. 1.	Do you use the library?	224	129
Q. 2.	How often? A range from weekly to yearly?		
Q. 3.	Should it be continued under the present policy?	269	22
Q. 4.	Should it be enlarged and the service improved?	139	70
Q. 5.	In what direction? A.: As the oldest society we should have the largest engineering library in the city, enlarged quarters, increase in all directions; Increase collection by addition of new and timely books; Improve mechanical engineering section, catalog the collection; Special services for industries of Chicago; Research services for members; Catalog of special books owned by members or special data which they would be willing to have open to inspection on application through librarian; Service to non-resident members abstract of important engineering articles published monthly in Journal; Charge for service; Compile index of books not in collection; Special Service for the industries of Chicago; Loan reference books; Make it a general engineering reference library equal or better than Crerar.		
Q. 6.	Same as Q. 4, if it means increase in expenditures?	97	84
Q. 7.	Would you like to have the library open evenings?	126	118
Q. 8.	Which evenings? A.: All evenings and Saturday and Sunday afternoon.		
Q. 9.	Can the librarian be of greater service to you by undertaking special work, such as compiling bibliographies, or making special searches, under a nominal or cost charge for the service?	64	162
Q. 10.	Do you desire additional periodicals in the library?	28	154
Q. 11.	Specify A. Electrical; Refrigerating; Heating and Ventilating; put a few popular magazines in as a sort of drawing card; Handbooks and house organs of manufacturers containing information as to their products; Motor transport; Postoffice electrical engineering; Foreign technical papers.		
Q. 12.	If you are an out-of-town member, state how the library can serve you better. A.: Furnishing short bibliographies; Photostat service; Supplying literature by mail.		

CIVIC ACTIVITIES AND PUBLIC AFFAIRS.

		Yes.	No.
Q. 1.	Do you think the Society participates sufficiently in local civic matters?	120	182
Q. 2.	Do you think the Society should attempt to secure greater publicity concerning its activities?	284	47
Q. 3.	If so, how? A.: By increased participation in public affairs, if this is done effectively publicity will follow; Endorse or condemn every civic activity; By popular reports on its activities and papers; More		

publicity of meetings held and announcement of coming meetings when speaker of note is to discuss a subject; By having representative before various civic bodies; By making the Journal a regular periodical; Send notice of meetings to some large engineering departments or works when subjects may be of interest to employes; Invite representative public men to our meetings.

Q.	4.	Should the Society endeavor to inform its members on the activities of the Chicago Common Council insofar as they concern engineers and engineering matters?	354	14
Q.	5.	Same as Question 4, State, Legislature?	348	15
Q.	6.	Same as Question 4, Sanitary District?	334	18
Q.	7.	Should the Society attempt to perfect a closer affiliation with the Chicago Association of Commerce?	302	45
Q.	8.	Should the Society endeavor to co-operate with municipal, county and state departments and bureaus?	317	24
Q.	9.	Do you favor a Society branch or Section on public affairs or civic matters?	241	78

INSPECTION TRIPS.

			Yes.	No.
Q.	1.	Do you favor inspection trips to nearby plants and operations of technical or engineering interest?	318	22
Q.	2.	How frequently? A.: The opinion seems to be in favor of quarterly excursions.		
Q.	3.	Do you prefer Saturday afternoon to mid-week trips?	225	69
Q.	4.	Suggest any inspection trips which you have in mind. A.: Some fifty valuable suggestions are included and referred to the Excursion Committee.		

EMPLOYMENT.

The Society maintains an employment bureau primarily for the use of its members and those introduced by members. The bureau also serves members of the national societies and co-operates with the employment bureau of American Engineering Council. However, the service is not confined to members because occasionally a capable engineer, who is not a member, applies for a position and our ability to place him with an employer will make new members for the Society. A registration file of "Positions Wanted" and Positions Available" is kept and published monthly in the Journal. No charges whatever are made for any of the services of the bureau. Although no one employe of the Society has devoted all of his time to this work, over 200 engineers were placed by the bureau in 1920.

			Yes.	No.
Q.	1.	Do you think that the present policy should be continued?	336	14
Q.	2.	Do you think that the service should be expanded?	201	87
Q.	3.	Do you think it should be conducted by a personnel officer?	132	133
Q.	4.	Under Question 3, how would you finance the increased expense? A.: Charge for service rendered; Raise dues; Give preference to members.		
Q.	5.	Should the service be limited to members?	165	187
Q.	6.	If not, should a service charge be made to non-members?	202	53

AFFILIATION AND CO-OPERATION.

			Yes.	No.
Q.	1.	Do you think an attempt should be made to affiliate all the engineering societies in Chicago?	228	118
Q.	2.	If your answer is "No" to Question 1, do you think the W. S. E. should co-operate with the other Chicago societies, holding joint meetings?	152	29
Q.	3.	Should the W. S. E. attempt affiliation with the national societies with some arrangement for commutation of dues?	228	83
Q.	4.	Should the Sections of the W. S. E. join with the local Sections of the national societies eliminating the duplication of officers, effecting in reality an affiliation with the national societies?	187	89

JOURNAL OF THE

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PROGRAM COMMITTEE

E. T. HOWSON, Chairman

December 1st Meeting—The Practical Application of the Telephone Repeater.

On Thursday, December 1, Mr. H. S. Osborne, Transmission Engineer, American Telephone & Telegraph Company, New York, will read a paper before the Society on the "Practical Application of the Telephone Repeater." This is a most interesting subject regarding the recent development of the telephone repeater and its application to long distance communication. The development of the telephone repeater in the last few years has been a prominent feature in the extension of the limits of long distance communication. The repeater is one of the recent remarkable developments in the art. The synopsis of Mr. Osborne's paper appears on another page.

December 5th Meeting—Economic Features of the St. Lawrence-Great Lakes Waterways Project.

The St. Lawrence-Great Lakes Waterways project probably has more possibilities for the commercial development for the City of Chicago than any other one project. Chicago as an ocean port will undoubtedly bring to its vicinity many large industries now located on the New Jersey shore and other eastern ports. Mr. Shenehon has made a number of investigations and reports on this and similar projects, and investigated the possibilities of a dam at Niagara to control the water level of the lakes. Some of Chicago's prominent men in other lines, other than engineering, who are interested in Chicago's future in connection with this project, are expected to be present to enter into the discussion.

December 15th Meeting—Economic Consideration of Line and Grade Revision Work on the Delaware Lackawanna & Western Railroad.

The Society will be most fortunate to hear Mr. Geo. J. Ray, Chief Engineer of the Delaware, Lackawanna & Western Railroad, on December 15. Mr. Ray is rendering a distinct service in discussing some of the facts brought out in the preliminary studies and comparison of the results actually secured in this important revision work, which comprises some of the most extensive work ever undertaken in this country.

December 16th Meeting—Application of Electric Power to the Iron and Steel Industry.

The features in connection with the generation and use of electric power now commonly found in other industrial lines or in central station work, will be taken up by Mr. W. S. Hall, Electrical Engineer of the South Works of the Illinois Steel Company. This is a joint meeting of the Western Society with the American Institute of Electrical Engineers, the American Society of Mechanical Engineers and the Association of Iron and Steel Electrical Engineers.

December 19th Meeting—Operation of Sewage Disposal Plants.

Mr. H. H. Wagenhals has in the last year or two made personally or has supervised the inspection of all the Sewage Disposal Plants in the country. The results of his observations is therefore based on extensive study of the subject. His analysis is most timely in view of the great importance to Chicago, as this city is now confronted with the problem of sewage disposal.

YOUNG MEN'S FORUM

December 3rd Meeting—Selling the Utilities to the User.

Mr. S. H. Sheel, Manager, Investment Bureau, Commonwealth Edison Company, Chicago, has solved the problem of educating the user of the service of a public utility company in regard to the benefits to be derived from being a partner in a business which provides one of his living necessities. Mr. Sheel will tell how this problem has been worked out.

American Institute of Electrical Engineers

In the last issue of the Journal it was announced that Mr. W. D'Arcy Ryan would deliver an illustrated lecture on "Illumination" before the American Institute of Electrical Engineers and the Western Society of Engineers. Mr. Ryan was suddenly called to Rio de Janeiro in connection with the matter of planning for the illumination of the exhibition to be held in that city, and it was therefor necessary to abandon the idea of giving his lecture. Very fortunately it was possible to secure in his place Dr. W. P. Davey, of the Research Department of the General Electric Company, with a paper having the interesting title, "The Elements of the Elements."

The following persons have recently applied for membership in the American Institute of Electrical Engineers:

F. M. Williams, LaGrange, Ill.
G. T. Kennedy, Chicago, Ill.

The following are new members recently elected or old members reinstated:

Clarence R. Gill, Chicago, Ill.
Lee Roy Smart, Chicago, Ill.
Charles B. Frankel, Chicago, Ill.
Fay Woodmansee, Maywood, Ill.
O. A. Havill, Chicago, Ill.

The following members have recently moved to Chicago or its vicinity:

Sheldon Bloomberg, Chicago, Ill.
O. K. Marti, Chicago, Ill.
T. I. Dekle, Chicago, Ill.
Edward W. Legier, Chicago, Ill.
Carl L. Rick, Chicago.
Otis B. Dorsey, LaGrange, Ill.
Oscar Burleen, Chicago, Ill.
James Apostolou, LaGrange, Ill.

On December 16, 1921, at 7:00 p. m., there will be a joint meeting with the Western Society of Engineers, Association of Iron and Steel Electrical Engineers and the Chicago Section of the American Society of Mechanical Engineers. This meeting will be held in the rooms of the Western Society of Engineers at 330 S. Dearborn street. A paper will be presented by Mr. W. S. Hall, Electrical Engineer of the South Works of the Illinois Steel Company. The subject will be "Application of Electric Power to the Iron and Steel Industry." Mr. Hall will describe features in connection with generation and use of electric power not commonly found in other industrial lines or in central station work, and his paper will contain many items of interest. The Chairman of Committee of Arrangements for this meeting will be Mr. J. L. Mills.

The January meeting will be held on the 18th at 7:30 p. m. in Fullerton Hall, Chicago Art Institute. A paper on "Radio Telephony" will be read by Mr. Ralph Bown of the Department of Development and Research of the American Telephone and Telegraph Company, and a demonstration of radio telephony and telegraphy will be given by Mr. R. H. G. Matthews, Director of Chicago Radio Laboratory. In view of the great interest among amateurs in regard to radio telephony and telegraphy, it is expected that this meeting will be largely attended. The Chairman of the Committee of Arrangements will be Mr. S. A. Rhodes.

Those persons in this vicinity—and in this instance, the vicinity includes the area within a radius of 500 to 1,000 miles of Chicago—who are so fortunate as to have access to an adequate radio set, are being greatly entertained these evenings by the music furnished by the Chicago Opera Company, in its performances at the Auditorium. This music is conveyed from the Auditorium to the Edison Building by wires and is then sent out broadcast by the Commonwealth Edison Company from the aerial structure recently erected on the roof of the Edison Building.

American Society of Mining and Metallurgical Engineers

On October 19 a luncheon was served by the Chicago Section of the American Society of Mining and Metallurgical Engineers, to welcome the out-of-town members who arrived for the American Mining Congress.

Mr. F. K. Copeland acted as toastmaster and responses were made by Mr. C. H. MacDowell, President of the Western Society of Engineers; Mr. Edwin Ludlow, President, A. S. M. and M. E.; Mr. William J. Loring, President of the American Mining Congress; Capt. R. W. Hunt, Past President of the American Society of Mechanical Engineers, and Mr. R. S. Billings, of Kingman, Arizona. The luncheon was served at the Blackstone Hotel and there were 158 present.

Society of Automotive Engineers

On November 25th Mr. P. S. Tice, of the Stewart-Warner Company, addressed the Society of Automotive Engineers (Mid-west Section) in the Western Society rooms. His subject was the "Vaporization of Fuels and other Physical Phenomena." It was a splendid paper illustrated by very interesting curves and by direct experiments giving a visual picture of the entire problem of vaporization.

Young Men's Forum

Mr. Benjamin Bills was the speaker at the Young Men's Forum on Saturday afternoon, October 22. "The Pursuit of Business," if it is successful, requires an orderly arrangement and presentation of the ideas which are to be developed. Mr. Bills has an order for presentation, as follows: First, comparison. That is, an illustration, which will attract the attention of the listener, followed by a suggestion and an appeal; then the explanation and a confirmation of this explanation leads directly to the opportunity of placing the conclusion before the listener and securing an acquiescence.

There were about forty of the young men of the Society present at this meeting and all were enthusiastic over the address by Mr. Bills. It was full of inspiration and good sane logic.

At the conclusion of Mr. Bills' address there was an evident desire on the part of many of those present to take up a systematic study of public speaking. Mr. John Dailey was appointed chairman of a committee to investigate the possibilities of such a class and report at the next meeting of the Young Men's Forum. Any member of the Society who would be interested in entering a class of this kind, may leave his name with the Secretary. There is no question as to the importance of a class of this kind among the younger members of the Society.

The attendance at the Young Men's Forum Saturday, November 5, showed that the topic under discussion was very near the heart of the engineer. Mr. A. W. T. Ogilvie, of the Swanson-Ogilvie Company, addressed the young men on the subject of "Business Management." Every business is conducted under some sort of policy, from the managing to the production, sales and financial end. Mr. Ogilvie filled in the gaps by his discussion of policies, human relations, records and organization.

At the end of the meeting the Committee on Public Speaking reported to the young men present. The committee reported that a course in public speaking was desirable. They recommended the selection of Mr. John Morrell to conduct the classes, and those present voted in favor of it. Twenty-six men signed up for the course. At the previous meeting approximately fifteen men signed up for the course, so now the class of public speaking has approximately forty men. The first class was held Saturday afternoon, November 12. On account of the great number of applicants for this course, it is thought advisable to break this class in two, having one class meeting on Saturday afternoon and one class meeting one evening a week. If any others desire admission into these classes, kindly advise the Chairman, Mr. John Dailey, who will take care of their requests.

Future Meetings

On January 9, Mr. L. R. Ash, of Harrington, Howard and Ash, of Kansas City, will talk before the Western Society on "The Design and Construction of the Akron Viaduct." The paper will be illustrated with slides and Mr. Ash will describe the interesting features of both design and construction.

On January 18, Mr. Ralph Brown, of the Department of Development and Research of the American Telephone and Telegraph Company, will give a paper on Radio Telephony, and there will be a demonstration of Radio Telephony and Telegraphy by Mr. R. H. G. Mathews, Director of the Chicago Radio Laboratory. This is planned to be a ladies' night and opportunity will be given to hear Grand Opera by radio.

Noon-day Luncheon—November 18

That the popularity of the Noon-day Luncheon has not waned was very forcibly shown at the Luncheon on November 18, when the Society was addressed by Senator John Dailey. The Cameo Room at the Morrison was filled to capacity. Senator Dailey reviewed briefly the purpose and work of the Dailey Commission of the Senate of Illinois in investigating the building situation in Chicago. The Commission is trying to interpret "common decency" in connection with the building industry. It was conscious that the public had little or no confidence in a legislative commission to investigate this subject because of the history of predecessors, which had been invariably a failure. The Commission had no one to step forward and give them help at the beginning of their investigation. Witnesses could not disclose what they knew and were compelled to commit perjury to protect themselves. The Commission was also handicapped by not being able to get money from the Attorney General's office to carry on its work and had to go on anonymous donations. Senator Dailey endorses the Landis agreement and urges all engineers, contractors and architects to stand by it and enforce it. It will get rid of all make-work rules and interference with foremen and all evil practices for uneconomic purposes. He is informed that during the last few months, since this agreement has been in effect that labor graft is now afraid to assert itself and urges that this should be made permanent. Engineers, contractors and architects share in the moral responsibility to keep crooked labor agents off of the pay-roll; to knowingly employ such men is a form of bribery. Although the Senator endorses collective bargaining and union organization, he realizes that labor agents have buried unionism with crookedness and labor needs collective honesty and collective responsibility in cleaning its house.

The Senator also took the occasion to outline some of the conditions regarding the financial end of building. Seventy-three per cent of the people in the city have no homes of their own. Crooked labor and building material men and the building finance situation are responsible. Poor housing is responsible for the crowded condition of the Juvenile Courts, and nearly one-half a million people are not living in decent homes. In comparison with some so-called mortgage bankers of Chicago, Shylock was a magnanimous gentlemen. On second mortgage loans, these so-called mortgage bankers charge 25 per cent where the loan is for but one year, and sometimes more than 25 per cent.

He advocated that the guarantee policy issued by the Chicago Title and Trust Company should be confined to actual value of the property. Another evil was that "any old thing" could be an appraiser, and after the appraisal has been made, bonds were sold on the property. He cited a case of a property worth $200,000 twenty-seven years ago, which had recently been appraised at $816,000 signed by a gentleman as "Appraisor-Engineer." Another light fingered appropriation of the term Engineer.

The Senator's address was well received.

Chief Engineers' Night

Chief Engineers' Night, September 26, filled the Western Society Auditorum to capacity. The moving pictures showing the operation of supply trains on the Southern Pacific Railroad and the method of handling supplies and reclaiming scrap, were interesting.

The meeting was opened by Colonel Arn, Chairman of the Section, and H. G. Clark, Assistant to the President of the C. R. I. & P. Railway, presided. Mr. C. A. Morse, Chief Engineer of the C. R. I. & P. Railway, gave a very interesting history of his professional life from the time he started at $35.00 a month. On one of his first jobs, he was sent out to report to a resident engineer and told that he would probably be gone about two weeks. When he arrived he learned that his new boss had a reputation for firing people and that the average length of time for a man there was about two weeks; hence he realized why they had told him that he had better pack his grip to be gone about two weeks. He said a recent pamphlet of the A. S. C. E. contained a report in which eight reasons for success in engineering were given, and the last one of these was a technical education, all the rest referring to the human and moral elements in a man's life.

Mr. H. R. Safford, Assistant to the President of the C. B. Q. Ry., made a very excellent analysis for the benefit of the young man in engineering, when he said that foresights had sufficient attention, but that backsights and adjustments were too often neglected and not corrected. He said that in comparison with old times and new, there was too much tendency to accomplish things by collective effort rather than individual effort and he saw the time when individual effort would be curtailed to a serious extent. He said our universities should incorporate in their engineering schools a course in business law.

Mr. C. F. Loweth, Chief Engineer of the C. M. & St. P. Ry., gave a very useful analysis of the things which best served a young engineer in making a success. These points were kindliness, observation and noting things in detail for future use, even though such mental notations may at the time seem unnecessary; imagination, benefitting by practical experience of others, and thoroughness of detail. He said that Mr. Morse remembered asking for a raise only twice. He said that he himself did not remember how many times he had asked for a raise, but he did remember particularly asking for a raise twice when he got it. There is an opportune time to ask for advancement. He said that capacity for hard work was a very important thing and that it is necessary for a man to have the courage of his convictions and to maintain the idea that service rendered was all important.

Mr. E. H. Lee, Chief Engineer of the C. & W. I. Ry., gave a very human talk regarding experiences with tenderfoot engineers in the early days of the West and told amusing stories regarding the rattlesnake and prairie-dog country. His formula for success was, first, horse sense; second, action; third, knowledge of human nature and, fourth, the ability to make friends.

At a time like this when we are suffering from depression, the engineers can take courage to know that similar setbacks have occurred in the lives of engineers now in advanced positions. The ideals and qualities of the former generation will win for this generation in the future.

National Research Council

At the regular meeting of the Division of Engineering, National Research Council, held September 16, Professor C. A. Adams resigned as Chairman to resume full-time teaching duties at Harvard.

Mr. Alfred D. Flinn, Secretary of Engineering Foundation, was elected Chairman of the Division of Engineering, National Research Council. Mr. Flinn will retain his present connection with Engineering Foundation and United Engineering Society.

October 3rd Meeting

On October 3rd, D. J. Price, engineer in charge of development work, Bureau of Chemistry, U. S. Department of Agriculture, addressed a meeting that overflowed the Auditorium and adjacent rooms. About 300 persons were present. Mr. Price brought with him a very interesting and instructive motion picture, showing experimental explosion work and effects of the Northwestern Elevator explosion at South Chicago. He illustrated his paper with a number of slides. The paper which is published in this issue of the Journal is a very clear analysis of the conditions and the factors entering into the grain dust explosion at the Northwestern Elevator on March 19th, 1921.

October 10th Meeting

On October 10th Mr. Thomas G. Philfeldt, Engineer of Bridges, City of Chicago, addressed about 200 Engineers at the meeting of the Bridge and Structural Section on the design and construction problems of the Wells street bridge. Mr. Hugh Young, Engineer of the Chicago Plan Commission, was Chairman of the meeting, and led in the discussion of the papers. A number of interesting slides, showing drawings and construction news, were shown. As this meeting occurred on the anniversary of the Chicago Fire, an interesting moving picture, entitled "The Tale of a City,' a film prepared several years ago by the Chicago Plan Commission was shown. This film showed the condition of Michigan boulevard, where the Link Bridge now is and also showed the then proposed Link Bridge improvement so that one could compare the actual improvement with the imaginary one.

Among those discussing the paper were Mr. C. H. Norwood, of the Norwood-Noonan Company, Engineer for the electrical equipment of this bridge and Mr. Kittler, who represented the contractors for the construction of the bridge.

October 17th Meeting

On October 17th The Western Society held an evening meeting devoted to the subject of Garbage Disposal. Mr. Lawrence F. King, President of the Sanitary District of Chicago, and Mrs. Samuel A. Greely, of Pearse-Greeley & Hansen, were the speakers. Mr. King gave an interesting talk describing the Municipal Garbage Plant of which he formerly had charge. Mr. Greely reviewed the latest developments and methods of garbage disposal in a number of American cities.

Dr. John Dill Robertson, Commissioner of Health, City of Chicago, was present and spoke with reference to the popular idea that garbage was a producer of disease germs. He said that disease germs are not produced in ordinary city garbage. Where there are sanitary sewers to carry off disease germ producing material there would not be a refuse or garbage that would produce disease germs. He did say, however, that garbage might produce disease germs indirectly through the feeding of rats which might carry germs.

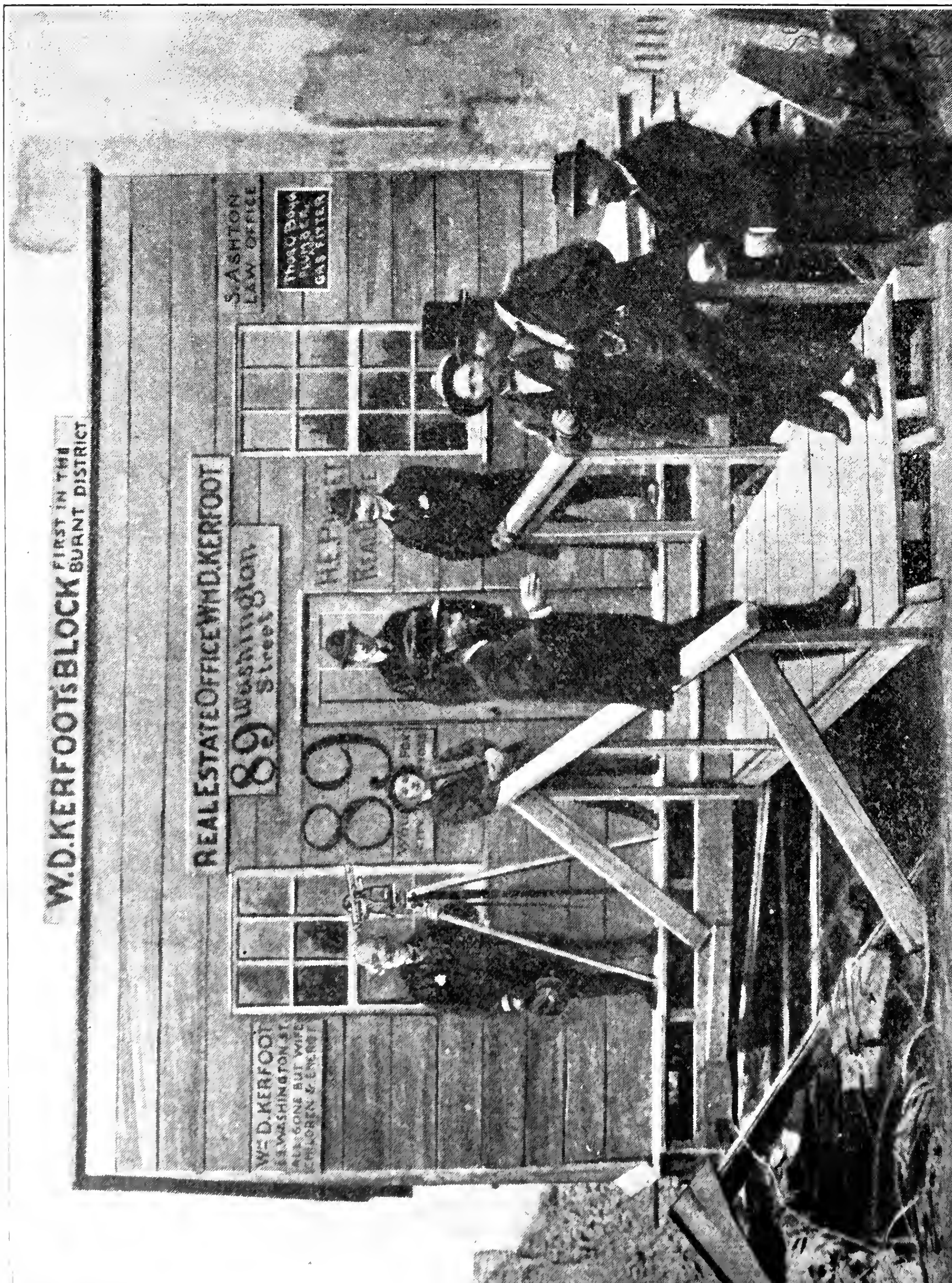
Miss Mary McDowell, representing the Womens' City Clubs, was also present and emphasized the fact that garbage disposal was a problem to be handled by technical men and not by politicians. She said women had been instrumental in securing the appropriation made by the icty to provide for the engineer's report to the City Waste Commission in 1914. Of this Commission Miss McDowell was a member, and Ald. Willis O. Nance was Chairman. The report was prepared by Osborne & Featherstone, Engineers, and its conclusions were adopted in principal by the City Council June 15th, 1914. Miss McDowell said she was much interested in having this followed up by engineers whom she felt should use their efforts towards its accomplishment.

A moving picture entitled the "Life of a Fly" was shown, and Mr. Greely showed a number of slides illustrating garbage plants in a number of cities.

November 7th Meeting

Col. W. V. Judson, U. S. A. Engineers, addressed the Society on the subject "Illiana Harbor." The paper was read by Maj. Putman, of Col. Judson's staff, while Col. Judson explained features shown on the lantern slides. About 200 people were in the audience, including members of the Chicago Chamber of Commerce and governmental officials. Illiana Harbor is a plan developed under Col. Judson's direction as Engineer of the Chicago District for a harbor at Wolf Lake on the Illinois-Indiana state line and adjacent to Lake Michigan. This shallow lake is to be dredged and wharfs built to accommodate future shipping and to be provided with ample railroad terminal facilities. The harbor also contemplates extensive wharfs and storage on the shore of Lake Michigan, adjacent to the Wolf Lake entrance.

Fixed bridges for Chicago River was a point brought up in the discussion. It is estimated that the cost of maintaining and operating the present swing and bascule bridges is about $4.00 per ton of freight accommodated. This amount if paid directly by the shipper would undoubtedly make unnecessary the construction of such expensive bridges. It was urged that this is a problem for investigation and action by the Western Society of Engineers.



Alexander Wolcott — Emil Rudolph — Geo. Birkhoff, Jr. — Wm. D. Kerfoot — W. A. Merigold — Sam Ashton

W. D. Kerfoot "Block"

Through the courtesy of Mr. Emil Rudolph we are able to reproduce a photograph of the Kerfoot "Block," the first building erected in the burnt district after the great Chicago fire. In the group shown in the photograph, there is represented the engineer, the lawyer and the real estate agent, as well as a plumber and gas fitter. The spirit which actuated the men who rebuilt Chicago is typified by the sign on the building, which reads:

"All Gone, But Wife, Children and Energy."

Mr. Alexander Wolcott, of the firm of Wolcott & Fox, City Surveyors, was a member of the Civil Engineers' Club of the Northwest, which later became the Western Society of Engineers. Mr. Wolcott attended Dartmouth College and came to Chicago in 1834, when he was 21 years of age. He was employed on the Illinois and Michigan Canal for a number of years and later with the Illinois Central Railroad when it was built into Chicago. He died in 1884 and was well known to many of the older members of our Society. Mr. Roswell B. Mason, who had formerly been the Chief Engineer of the Illinois Central Railroad and was the first President of the Western Society of Engineers, was mayor of the city of Chicago at the time of the fire. Mr. Emil Rudolph, then a lad of sixteen, was employed with the firm of Wolcott & Fox.

Roswald B. Mason

The Chicago School Board has named the school building at Eighteenth and Keeler Avenue, Chicago, the Roswald B. Mason School.

This honor is conferred inasmuch as Mr. Mason was Mayor of the city of Chicago at the time of the great fire in 1871. He was at the same ttime the President of the Civil Engineers' Club of the Northwest, which was later changed to the Western Society of Engineers.

In the early days of this Society, when there were few who had the vision or were able to give the effort to the upbuilding of an engineering society in the Middle West, Mr. Mason was one of the most active and one whose vision had large things for the future.

Book Plate

The books in the library of the Western Society of Engineers do not contain a Book Plate. The Library Committee is of the opinion that we should have one, but up to the present time none has been provided.

Believing that the members of our Society will be interested, we request that designs be submitted for the consideration of the committee. May we not receive your suggestion. Certainly there are members qualified to make such designs.

Public Affairs Committee

At a meeting of the Public Affairs Committee held Monday, November 14th, Dr. John Nolen, of Cambridge, Mass., presented an informal but a very interesting and instructive address.

Dr. Nolen with numerous very apt illustrations, showed to what a large extent the engineer can serve the community without overlooking the interest of his special employment. He said that while civic improvements, such as city planning and zoning, were largely engineering matters, yet it was the fact that engineers have served in a very minor capacity in all these things.

There were present at this meeting about thirty of the members of the Public Affairs Committee. Realizing the importance of an address fro ma man of a very wide experience of Dr. Nolen, he has been asked to come back sometime and address the technical meeting of the entire Society.

Class In Public Speaking

The first meeting of the Class in Public Speaking was held Saturday, November 12, at one o'clock, in the Society rooms. Mr. John Morrell, Chairman of the Speakers' Bureau, was chosen leader of the class. Over twenty were in attendance at this meeting and will be in attendance at the balance of the meetings, which consist of ten sessions.

This is an interesting development among our younger members and when the opportunity came, there was a response, spontaneous, and indicative of a desire of many of our members to better prepare themselves for public speaking. The class is self-sustaining. Mr. John Dailey was chosen Chairman and Treasurer.

Cooley Succeeds Hoover In Engineering Council

At a meeting of the American Engineering Council held in Washington September 30, Mortimer E. Cooley, dean of the Colleges of Engineering and Architecture of the University of Michigan, was chosen as president of the American Engineering Council and the Federated American Engineering Society. Mr. Cooley succeeds Mr. Herbert C. Hoover, the first president of the Federated American Engineering Society.

Professor Cooley is the past president of the American Society of Mechanical Engineers and the past director of the American Society of Civil Engineers. For the past forty years he has been in charge of the Engineering Department of the University of Michigan and his great sympathy with the young men in the profession and his thought and foresight, is well-known to us all.

Another Engineer Citizen

A few days ago one of our active committee members stated to the Secretary that during the last two years he had increased his activity in the Society in a way which was very helpful to himself. From a selfish standpoint he felt that he had received a great deal of benefit. He had increased his acquaintance, he had become a part of and in contact with the engineering enterprises of the city as a whole. Because of these things, he had also received benefit by an increased position in his own neighborhood in his relations to his neighbors, gaining prestige by his activities in the Western Society.

This member also recognized the fact that aside from the selfish interests which are affected by his cooperation and activities, he had gained for the profession and for the Society considerable advantages by raising the prestige of the Society among those with whom he came in daily contact. Needless to say, he has enjoyed all of this work, although it has taken a considerable amount of time.

This is not an isolated case. It is a matter of great deal satisfaction for the Secretary to be able to report to the membership that we have a large and growing number of members who are realizing the opportunities of this kind and offering themselves for service to the Society on its committees and in taking part in its program of technical meetings as well as assuming responsibility as an engineer citizen.

Uniform Contracting Practice

A conference has been called for Deecmber 15 in Washington to consider a method of securing more uniform contracting practice by the establishment of standard specifications for engineering work.

This important matter has been considered by a number of agencies for some time. It is encouraging to know that active steps have been taken to crystallize opinions on this important matter.

Delegates from the following Societies have been requested:

The American Association of State Highway Officials.
American Engineering Council.
American Institute of Architects.
American Railway Engineering Association.
American Society of Civil Engineers.
American Water-works Association.
Associated General Contractors of America.
National Associated of Builders' Exchanges.
Western Society of Engineers.

American Civic Association

The Seventeenth Annual Convention of the American Civic Association was held in Chicago, Nov. 13-17, 1921. The sessions of the Association were held at the Drake Hotel.

There was in attendance at this conference a number of prominent representatives of civic organizations from all over the United States. The meeting had special reference to Chicago and a number of the papers were of special reference to the Betterment Plan for our city. The program for Monday, Nov. 14th, consisted of a symposium, "Who is Doing the Civic Work in the Town?"—"What are the Signs of the Times?"

Mr. R. F. Schuchardt, M. W. S. E., presented the subject "The Technical Society." His address is as follows:

"To have suggested even five years ago that technical societies were concerning themselves to any large extent, as organizations, with matters of good citizenship, would have brought a smile of incredulity—yet today no such society prepares its programs without giving attention to these matters. This is but another of the beneficial effects of the war—part of the general awakening.

"I do not mean to imply that engineers have been transformed overnight, as it were, from indifferent citizens to ardent altruists, keen for civic service. They were not indifferent citizens before nor do they indulge in promiscuous altruism now—but they are awake at last to the special obligation which rests on them because of their special training. An engineer's entire education teaches him that if he does not make truth his constant companion in the solution of problems he will fail. This develops a habit of going straight at the cause of things to learn the real facts and with these to analyze the case—surely a good method of attack for use on our complex civic problems.

"The modern technical society, while a professional organization, recognizes this opportunity for civic service and encourages its members to participate in public affairs; and they do so participate, not primarily as engineers, but as citizens with a specially helpful training.

"The value of this participation in civic matters can be well understood when we consider how much city government is an engineering proposition. City planning and urban transportation, two closely interwoven problems, traffic terminals, municipal improvements, public utilities, smoke abatement, water and sewerage, highways, bridges, etc.—all are largely engineering.

"There is another special obligation imposed on the engineers by the fact that the improvement in machinery, in rapid transit, in building construction, in electrical devel-

opment, etc., are all the work of the engineer —and these, while they have added immeasureably to the general welfare and comfort, have brought the rural population into the city in such numbers as to result in fearful congestion. The engineer is ready to cooperate with the other professions in the solution of the many difficult problems resulting from this condition.

"He appreciates that this solution should not be expected from any single profession or even from a small group, but that every profession or group—the doctors and lawyers and architects, social workers, engineers of various kinds, and others; in fact, all who can contribute anything of value to the problem, should be consulted.

"The Public Affairs Committee of the Western Society of Engineers, the local general engineering society with a membership of about 2,700, during this last year submitted a total of 28 reports, each the result of careful study and covering a wide range of subjects—all of public importance. Among them were Thompson Traction Plan, several phases of zoning, Constitutional convention questions, parks, bridges, water supply, sanitation, civil service, State Public Utility bill, municipal bond issues, and more of like nature. This just by way of illustration of the engineer's civic activities.

"The recognition which comes from these efforts and which is expressed by the appointment on a city commission of an engineer who has been active on the subject to be treated by the commission, and by editorials in leading newspapers in which the Western Society of Engineers is named and lauded with other civic bodies such as those represented here in this notable gathering—such recognition is encouraging, but recognition or none, we are glad and proud to take our place in this goodly company of forward looking men and women to co-operate with you in trying to make our cities not mechanical monuments to Mammon, but places of beauty and health where industry is prosperous and where life acn reach its fullest and highest development."

Mr. John Ihlder, Director, Civic Development Department, Chamber of Commerce of the United States, presented a very broad view of the entire civic work. The following extracts are from his address:

"Whenever possible a direct question should have a brief, direct answer. You ask, 'Who is doing the civic work in the towns?'

"My answer is, 'Where civic work that has real worth is being done, it is done by citizens.'

"But the trouble is that when a direct question deals with fundamentals, the brief, direct answer leaves so much unsaid. The answer must be elaborated.

"All of us who are to speak here this morning are citizens and represent organizations of citizens. That is our primary qualification and that of our organizations for dealing with civic subjects. If we were aliens, if we held lightly or entirely disregarded our rights and duties as citizens, we should be disqualified.

'But the question asked, when followed by the list of organizations whose representatives are to answer it this morning, indicates that there was in the questioner's mind a belief that these particular organization, or perhaps even that some one of them may claim that it is doing the civic work in the towns.

"The work civic, I understand, is here intended to include all that affects the community as a whole and to which citizens as citizens are asked to contribute effort or money. It includes social work as well as that is more narrowly styled civic. With such a definition I would say that no citizen is outside the fold unless he disfranchises himself and unless he is so poor that he can not pay even a poll tax. From which it follows that no organization less than the community as a whole can claim a monopoly in doing the civic work of the town.

"Probably no one will disagree with this, but many will claim that it begs the question, which in reality is, 'Who takes the lead in doing civic work; What organization or organizations contain those dynamic citizens who generate ideas and put them over?' That is, it is a question of leadership we are discussing. But before we leave the previous question I would interject a query. What is the real purpose of civic work? Is it to secure some tangible, concrete thing, such as a park or a new city charter, or even to restore to self support a family that has been down and out? Or is it to develop the individual citizen, give him a broader vision, greater understanding, increased strength of mind and soul. These come only through decision and action, through doing. If they furnish the real purpose, then the tangible, concrete accomplishments are mere by-products, valuable enough in themselves to justify our efforts but insignificant when compared with our increased strength to go on to ever greater accomplishment. And if this is the real purpose, then we can not afford to exclude any portion of the community, any individual, from his share in the work.

"Now for the question of leadership. Democracy by putting before the individual citizen the necessity for deciding on moot questions, develops men. But it also puts upon the individual citizen responsibility for deciding upon so many things that, being human, he can not adequately inform himself upon them all. He must to a considerable extent specialize upon a few. For the rest he

must depend upon the advice or leadership of others who in general share his point of view, upon whose honesty of purpose he relies, and who have themselves specialized upon the subjects of which he is ignorant. Leadership in the community, consequently must be divided and the leader will change according to the subject at the fore.

"In this matter of leadership not only knowledge, but point of view also is of first importance. For this reason it is important that we organize groups from our citizenry which will represent the most significant points of view. In these troups matters of public concern can be threshed out, a logical presentation developed, impossible without group organization. Then this point of view will be presented most effectively for the community's verdict. Such an effective presentation of points of view is service of the first importance in any community, and especially so in a democratic community."

It was of interest to note the fact that a large number of the subjects, which were under discussion and of the matters which have been handled by the various civic organizations, have as their basis engineering. For this reason, the activities of the Western Society of E7ngineers and the promise of the future activities, speaks well for the engineering profession doing its civic duty.

"The Practical Application of Telephone Repeaters"

Synopsis of Paper by H. S. Osborne*

Before the Society, Dec. 1, 1921

Introduction. In transmission over long telephone lines, the energy represented by telephone currents becomes greatly reduced because of line losses. The purpose of the telephone repeater is to restore the energy, keeping unchanged the characteristics of the telephone current.

Repeater Elements. A brief description will be given of the two types of repeater elements in use, the mechanical type and the vacuum tube type, with the characteristics of each.

Application of Repeaters to Lines. As the telephone repeater is inherently a one-way device, its application to telephone lines is necessarily through the medium of a circuit arrangement making possible two-way operation. The more important types of circuit in use will be briefly described. In order that these circuits may operate satisfactorily, it is necessary to meet rigid requirements in all features of construction of the telephone lines which affect their electrical characteristics. These requirements apply throughout the entire lengths of all lines used with repeaters.

Some repeaters are used as permanent parts of given telephone lines and other repeaters are arranged as a part of cord circuits so that they may be connected between any two telephone lines suitable for their use.

Transcontinental Line. A description will be given of the use of repeaters on the transcontinental line and the results obtained measured in terms of increased efficiency or decreased weight of copper required.

Boston-Washington Cable. The use of repeaters in connection with this underground toll cable system, 450 miles in length, will be described showing the large technical and economic improvements obtained thereby.

Cuba Cables. An outline will be given of the peculiar problems which had to be met in providing service between the United States and Cuba and in spanning the Florida Straits with telephone cables suitable for this purpose. The important part played by the use of repeaters in the solution of this problem will be indicated.

New York-Chicago Cable. A modern telephone cable of the latest type, which in a few years wili extend from New York to Chicago, is already in service from New York to Pittsburgh, and is being extended to Cleveland. This cable employs very small conductors and telephone repeaters at frequent intervals. The problems encountered in connection with this project and their solution will be briefly described.

*Transmission Engineer, American Telephone & Telegraph Co., New York.

The Engineer

Robert Louis Stevenson has written the following:

"And the truth that the engineer most properly deals with is that which can be measured, weighed and numbered.

"These are the certainties of the engineer; so far he finds a solid footing and clear views. But the province of formulas and constants is restricted. Even the mechanical engineer comes at last to an end of his figures, and must stand up, a practical man, face to face with the discrepancies of nature and the hiatuses of theory. After the machine is finished, and the steam turned on, the next is to drive it; and experience and an exquisite sympathy must teach him where a weight should be applied or a nut loosened.

"With the Civil Engineer the obligation starts with the beginning. He is always the practical man. The rain, the winds and the waves, the complexity and the fitfulness of nature are always before him. He has to deal with the unpredictable, with those forces that "are subject to no calculation," and still he must predict, still calculate them at his peril. His work is not yet in being and he

must foresee its influence; how it shall deflect the tide, exaggerate the waves, dam back the rainwater or attract the thunderbolt. Nay, and more; he must not only consider that which is, but that which may be."

This quotation is printed on the fly-leaf of the annual report of the water commissioner of the city of St. Louis, dated April 20, 1921. The printing of this in a public report addressed to the city authority is commendable. Every engineer owes to himself and to his profession to take every step possible to bring the importance of the engineering profession before the public.

Book Review

By E. O. Griffenhagen,* M. W. S. E.

"Time Study and Job Analysis," by William O. Lichtner. First Edition, 1921. Cloth binding. Ronald Press Company, New York. 400 pages, illustrated, $6.00.

While there has been no satisfactory definition given thus far to the term "scientific management," nor any general agreement reached as to the scope of its field, its two major principles are generally understood to relate to the concepts "standardization" and "planning." Mr. Lichtner's book deals with the first of these. It treats of the technique of the analysis of processes, the time study of operations, the standardization of processes and operations, and the application and uses of the standards all in their relation to the science and art of industrial management.

There are 23 chapters and six appendixes in the book. As explained by the author in his preface, the first five chapters deal with the principles of job standardization, the next three with the organization of the staff to carry on the work, the next fourteen with the technique of time study and job analysis, and the three last with job standardization in its relation to various industrial problems.

Ninety per cent of the value of this valuable book is to be found in the chapters that set forth the methods of standardization—Chapters VIII to XX, inclusive. In these pages the author first indicates how and why co-operation must be secured. He then discusses the relative amounts of time that must be given to the various phases or stages in the work itself and sets forth what the four important stages are, namely, (1) preliminary work, (2) taking the times, (3) analyzing the studies and selling the standards, and (4) applying the standards. The subsequent chapters take up these four processes in turn and describe the technique clearly and fully. Illustrations, tables, and examples drawn from an active practice help to make the explanation complete. The subjects of fatigue and very important problem of wage or rate setting are also each dealt with, although not as fully as might be wished.

The first forty-eight pages of the book are unquestionably the least valuable—they include considerable repetition and could readily have been condensed into one introductory chapter. It would also seem that Chapters VI and VII on personal requirements and personnel training could better have been put after the sections on technique. These chapters are also rather longer than justified by their relative value and the wisdom of allotting four pages to a printing of simple slide rule problems (pages 100-104) is doubtful.

The appendixes are interesting as statements of the accomplishments and possibilities of standardization work and scientific management but are not very closely related either in subject matter or form of write-up to the main theme of the book.

Mr. Lichtner has done a service to his profession in writing this book. He has strengthened a very thin place in the literature of "management." While there is no dearth of general works attempting to cover the whole field of industrial efficiency there are all too few practical and specific treatises on even the highly important phases. Time study and job analysis had not until this book was published been covered in anything like the precision and detail that its importance demands.

*Director Griffenhagen & Associates, Ltd.

News Notes

The American Wood Preservers' Association will hold their convention January 24th and 26th, 1922, in Chicago. G. M. Hunt, Madison, Wis., is Secretary.

French laws pertaining to hydro-electric plants in France and French colonies have been translated and are published in a 12-page typewritten report, which may be had by application to A. W. H. Griepe, 707 Prospect avenue, New York City.

The Mineral Point Zinc Company has issued an eight-page typewritten list of equipment for sale. This includes all kinds of industrial equipment and may be obtained by addressing the Purchasing Agent, W. B. Brown, 111 Marquette Building, Chicago.

"The Laws of Thermodynamics" is the subject of an address to be given by Professor C. A. Norman, of Ohio State University, at the December 29th meeting of the Midwest Section of the Society of Automotive Engineers, Chicago. The meeting will be held in the Western Society rooms.

The life of George Westinghouse, by Colonel Henry G. Prout, C. E. A.M. L. L. D., published by the American Society of Mechanical Engineers, is being offered at a special subscription rate to members of the four National Engineering Societies.

Mr. Harrison Eddy's paper on "Lights and Shadows of the Activated Sludge Process," presented before the Western Society of Engineers and published in the July, 1921, Journal, has been translated by Karl Imhoff, of Essen, Germany, and is being published in Germany by him, with the permission of Mr. Eddy, of Metcalf & Eddy, and of the Western Society of Engineers.

The combined musical clubs of the Massachusetts Institute of Technology will make a trip from Boston to Chicago during the Christmas holidays, giving a number of concerts at various cities. Their concert here will be under the auspices of the Technology Club of Chicago and will be held on Friday, December 30th, at the Blackstone ball room followed by a reception and dance. G. A. Tomlinson, 1537 Conway Bldg., is Secretary.

In a letter addressed to W. O. Winston, President of the Associated General Contractors of America, Herbert Hoover, at the close of the session of the employment conference, declared construction to be the key of the present situation; for as shown at the conference every two hundred men employed in actual construction sets to work from 500 to 700 men in basic industries such as lumber, cement, transportation, mining, manufacturing, etc.

E. H. Frost has been named Chief of Staff of the Chicago Zoning Commission, and Mr. E. H. Bennett has been made Chairman of the Staff, and Engineer of the Commission. Mr. Frost and Mr. Bennett have been associated in the work of the Chicago Plan. They are beginning an active survey of the city in connection with the preliminary work of the Commission. Mr. William E. Parson, of Bennett & Parsons, will also give the benefit of his knowledge to the Commission. Mr. Parsons has associated with the late Daniel Burnham and worked out the Manila Plan in behalf of the government. The quarters of the Commission are in the Andrews Building, Chicago.

Prof. Henry S. Jacoby

Cornell graduates will be greatly interested in the retirement of Prof. H. S. Jacoby, who for thirty-one years has been a member of the faculty of the Engineering College and for the last twenty-one years full professor and head of the Department of Bridge Engineering. Professor Jacoby will retire at the end of the college year next June, having reached the age specified for retirement.

Personals

Mr. Peter M. Larson, M. W. S. E., formerly with the Mutual Oil Company, of Chanute, Kansas, is now located in Chicago and is engaged in appraisal work.

Mr. Samuel Klein, consulting structural engineer, announces the removal of his offices to 225 E. Erie street, Chicago, Illinois.

Mr. R. F. Schuchardt, M. W. S. E., has been elected President of the University of Wisconsin Club of Chicago. The club meets every Friday for luncheon at the Palmer House.

Mr. F. C. Loweth, M. W. S. E., formerly assistant engineer of track elevation for the Chicago, Milwaukee & St. Paul R. R., has become the fuel agent of the Cleveland Electric Illuminating Company, with offices in the Illuminating Building, Cleveland, Ohio.

Mr. Howard W. Evans, M. W. S. E., former President of the Evans Bliss Company, has become an associate of the firm of Whitney & Ford, 4325 Cottage Grove avenue, Chicago. This firm deals in pipe, fittings and supplies.

Prof. Lewis C. Monin, Dean of the Cultural Studies of the Armour Institute of Technology, has been granted a leave of absence until September, 1922. A large part of this time will be spent in European travel. Prof. Nonin sailed from Montreal, Canada, on November 4, 1921.

Mr. O. C. Simonds, M. W. S. E., has been engaged for some time in preparing plans for an Arboretum at Downer's Grove. This is to be known as the Morton Arboretum and is provided for the citizens of Chicago by the donation of 400 acres on the east fork of the Du Page River, by Mr. Joy Morton. It will be open to the public in about two years.

Mr. Frank T. Sheets, formerly engineer of design, Illinois Division of Highways, has been made superintendent of highways, succeeding Mr. Bradt. Mr. Sheets has been connected with the Division of Highways since 1914, when he was appointed Assistant Engineer. As engineer of design, he has supervised the work of the offices of Road Engineer, Bridge Engineer and nine District Engineers of the Highway Division on location, survey, plan, estimate, specifications and contracts, for work amounting to about $35,000,000.

Mr. Theodore F. Laist, M. W. S. E., formerly Major of Engineers, U. S. A., Construction Division, announces that he has resigned as Architect, Central District, Bureau of Valuation, Interstate Commerce Commission, to become Chicago Representative of the National Lumber Manufacturers' Association, with offices at 111 West Monroe street, Chicago.

Mr. George S. Allison, Comptroller of the Armour Institute of Technology, was elected Vice-President of the State Organization of University and College Business Officers, which held the first meeting at Peoria, Illinois, recently. Twenty-three universities and colleges of Illinois were represented. The organization is to be permanent and will meet annually.

Mr. William Robert Wilson, formerly Vice-President of the Irving National Bank, New York City, has been elected to the presidency of the Maxwell Motor Corporation and the Chalmers Motor Corporation. Mr. Wilson graduated from the Armour Institute of Technology in 1909, and the engineering degree of Mechanical Engineer was conferred upon him by the Institute in 1911.

Mr. John A. Dailey, M. W. S. E., has been in attendance at a conference in Washington, called by Mr. Herbert Hoover, Secretary of Commerce, in the matter of standardization of paving bricks. Mr. Dailey represented the Western Society of Engineers. This conference consisted of representatives of the Bureau of Standards, Manufacturers, United States Chamber of Commerce and Engineering Societies.

Mr. H. J. Burt, of Chicago, M. W. S. E., General Manager of Holabird & Roche, will supervise the work of planning and building the new memorial stadium for the University of Illinois. This stadium will cost about $2,000,000. The feature of the proposed plan is a three-deck arrangement for seats, an idea which has never before been tried in American university stadiums. This plan enables the spectator to sit nearer the playing field and eliminates curved ends.

Prof. John F. Hayford, M. W. S. E., Director of the School of Engineering of Northwestern University, has recently completed a report upon which he has been working for eleven years for the Carnegie Institute. The problems upon which Professor Hayford has been working is to discover means for calculating the evaporation from the surfaces of the Great Lakes and the slopes of the lake surface caused by the wind and various barometric changes. The whole problem when worked out will provide a means for figuring accurately the lake level and will provide a basis upon which can be figured the amount of water that can be taken by cities like Chicago for the drainage of sewage and the amount of water that may be used at Niagara for power.

WM. MAXWELL McCARTNEY

William Maxwell McCartney was born at Youngstown, Ohio, November 12, 1866.

Shortly after graduating from the Rensselaer Polytechnic Institute at Troy, New York, in 1894, he went into the employ of the Sanitary District of Chicago. Here he served in various capacities durig fourteen years, becoming Assistant Engineer under Isham Randolph. Mr. McCartney had charge of the construction of the Bascule Bridges in Chicago, the building of the power house at Lockport, Ill., and the four miles of the drainage canal between Lockport and Joliet.

When this work was completed, he spent a year or more with the Chicago, Milwaukee & St. Paul Railroad, but was called by the city of Youngstown to return to his old home to superintend the building of a large dam and reservoir at Milton, Ohio, to supply water for the steel mills. In 1918, Mr. McCartney went into the real estate business, as president of the McCartney Realty Company. His illness, the direct result of tonsilitis, was of short duration, and he died April 3, 1921.

Development Committee

Every member should read this report.

By formulating the problems and possibilities before the profession in the community, the Committee has rendered a splendid service.

While most of the facts may be conceded, it is well to have them in mind so that the members may make suggestions, which will assist the Committee in working out a definite plan of co-operation. The splendid relations, which exist now, speak well for the future.

The report is as follows:

November 10, 1921.

To the President and Board of Direction,
Western Society of Engineers.

Gentlemen:—Your Development Committee takes pleasure in submitting for your consideration the following statement which it believes you will subscribe to, and a definite recommendation for action which it suggests be started immediately.

With the experience of the past and an appreciation of the present situation in mind, the desires of the profession may be broadly stated as follows:

1.—Maintenance of high ideals, both professional and civic, so the profession will continue increasingly to be worthy of the respect and confidence of others—

(a) by action constantly consistent with professional ethics,

(b) by active participation in matters that concern the common weal and particularly in those where the engineering experience especially permits a sound judgment.

2.—Improvement in the knowledge of those things that concern engineering—

(a) by spreading information regarding successful practices,

(b) by encouraging research.

3.—Greater publicity of the contributions to progress and to general welfare possible through engineering; i. e., by the engineer—

(a) by engineers taking advantage of opportunities to speak before civic and commercial and neighborhood bodies.

(b) by engineers making opportunities for so speaking,

(c) by engineers taking an active part in public affairs,

(d) by engineers improving their ability as public speakers.

These desires can be best fulfilled by co-operative action of those engaged in the profession; i. e., in association.

Engineering societies of various kinds have been organized to carry out part or all of these desires.

The stronger the society and the more inclusive is its membership, the greater is its potential ability to carry out desired programs.

The solidarity of a society is furthered by frequent personal contact of the members with each other.

A local society offers to the professionals in the locality a means for organized expression and an engine with which to carry out the desires.

A national society offers to the professions of the country a means for carrying out principally desires 1 and 2 outlined above.

There is no competition between local societies and national; each has its field and functions most successfully when it supplements the other by organized co-operation. The local is general in scope and covers the entire technical field while the national is special; i. e., covers one of the branches of technology.

The local society should have either as part of itself or in close affiliation with it the local chapters of all national technical societies.

It is the belief of the Development Committee that in joining an engineering society the following principles should guide:

(a) An engineer is first of all a citizen and as such should take an active interest in community questions and in the discussion of such questions should apply the special knowledge which his technical experience gives him. This is a duty which he owes to himself and to his fellows and it can be most effectively expressed through membership in a local technical society.

Such membership in a local society brings him into that personal contact with others of his profession, including those who occupy leading positions, which is generally a material factor in his progress.

(b) Having taken his place with his colleagues in the local field the next step is to ally himself with the national society of his specialty.

Assuming the correctness of these formulae, it is evident that Chicago, probably the most important industrial city in the world, should have a strong local technical society with a close working arrangement with the national technical societies. There is now a comparatively large number of local technical societies of various sizes and interests in this city. It should logically fall to the lot of the largest and oldest of these to offer the rallying ground on which all can gather. This one is the Western Society of Engineers.

The Development Committee therefore recommends that as a first step toward fulfilling the desires heading this statement, a definite program be worked out looking to the amalgamation of all technical societies of Chicago and a definite plan of co-operation (including a joint dues arrangement) with the local chapters of the national technical societies.

Respectfully submitted,

DEVELOPMENT COMMITTEE,

(Signed) R. F. Schuchardt, Chairman.

Approved and ordered published by the Board of Direction November 21, 1921.

EDGAR S. NETHERCUT,

(Signed) Secretary.

B-1184: DRAFTSMAN FOR OIL REFINING company and experience in appraisal work of gas company, age 25, attended Armour Institute.

B-1183: GRADUATE UNIVERSITY OF ILLINOIS, architectural engineering, designing structural engineer and construction superintendent.

B-1182: Member A. S. M. E., GRADUATE PURDUE in M. E., formerly employed by sales engineering company and tube manufacturing company and by manufacturers of mechanical equipment as chief draftsman.

B-1181: EDUCATION, UNIVERSITY OF CHICAGO and Alexander Hamilton Business school, experience with electrical engineer on design heavy coal and ore handling machinery, also in sales, age 31, desires position purchasing electrical machinery or general engineering and selling.

B-1180: AGE 23, GRADUATE LOYOLA UNIVERSITY, assistant on U. S. Geological survey for several years, map draftsman.

B-1179: GRADUATE OF GEORGE WASHINGTON University, experience as rodman and levelman. Age 22.

B-1178: GRADUATE OF ROYAL POLYTECHNICUM in Stockholm, Sweden, member Swedish Engineering society, draftsman, designer of packing house machinery, mining machinery, speak four languages, experience as chief engineer of power house construction and other construction.

B-1177: GRADUATE IOWA STATE COLLEGE in electrical engineering, A. I. E. E. & I. E. S. Societies, experience as assistant engineer and sales engineer in electric time systems for factories, sales engineer railway supplies and car lighting equipment.

B-1176: JUNIOR A. S. M. E., GRADUATE Brooklyn Polytechnic in Mechanical engineering, 2½ years machine shop, 2 years machine design, 8 months systematizing production, routing and time study experience.

B-1175: MECHANICAL ENGINEER, 4 YEARS New York University, age 25, experience in engine and air brake inspection, general machine shop and construction work.

B-1174: MEMBER AMERICAN ASSOCIATION Engineers, Technical High School, speak French and English, map draftsman.

APPLICATIONS FOR MEMBERSHIP

Applications presented to the Board of Direction November, 1921, and received since the last meeting:

No.	Name.	Address.
81.	Harold Arthur Peterson	3251 Michigan Ave., Chicago, Ill.
82.	Leonard M. Holmes	3251 Michigan Ave., Chicago, Ill.
83.	Harper Leslie Grove	8821 S. Racine Ave., Chicago, Ill.
84.	Theo. J. Kauders	6751 Clyde Ave., Chicago, Ill.
85.	H. C. Beck	6535 Greenwood Ave., Chicago, Ill.
86.	John P. Bambach	946 Irving Park Blvd., Chicago, Ill.
87.	Geo. Goldhart	7753 May St., Chicago, Ill.
88.	C. W. Carlson	3018 Vernon Ave., Chicago, Ill.
89.	Robt. S. Mayo	4650 Malden St., Chicago, Ill.
90.	Simon Rotberg	5108 W. Madison St., Chicago, Ill.

Members are requested to communicate with the Secretary with regard to qualifications of the above applicants for membership in the Society.

EDGAR S. NETHERCUT,
Secretary.

NEW MEMBERS

No.	Name. Address.	Grade.
37.	Jefferson D. Harris, Shreveport, La	Associate
63.	Gordon Fox, 645 Peoples Gas Bldg., Chicago, Ill	Member
64.	Herman N. Simpson, 6811 Emerald Ave., Chicago, Ill	Associate
65.	Frank D. Danielson (Transfer), Village Hall, Glencoe, Ill	Junior
66.	George E. Wolff, 1240 Glenlake Ave., Chicago, Ill	Student
67.	Raymond J. Graham (Transfer), 213 N. 19th St., Louisville, Ky	Associate
68.	Frank G. Welsch, 2801 S. Michigan Ave., Chicago, Ill	Junior
69.	Roy M. Singer, 2325 N. Kedzie Blvd., Chicago, Ill	Junior
70.	Carl August Wittlinger, Dubuque, Iowa	Associate
71.	Otto Wundrack, 815 N. 5th Ave., Maywood, Ill	Member
72.	H. I. Hettinger, 879 Stephenson St., Freeport, Ill	Junior
73.	J. C. Sanderson (Re-admitted), 2705 Hartzell St., Evanston, Ill	Member
74.	Henry A. Auerbach, 6751 Cornell Ave., Chicago, Ill	Student
75.	Elmer B. Mason, 609 E. 62nd St., Chicago	Student
76.	Lewis K. Sillcox, Box 579, Herrick Road, Riverside, Ill	Member
77.	Frank A. Randall (Transfer), 19 S. LaSalle St., Chicago, Ill	Member
78.	Harold W. Munday, 5658 Ridge Ave., Chicago, Ill	Student
79.	Edwin M. Goodman, 1719 Ridge Ave., Evanston, Ill	Student
80.	Earl G. Millison, 2802 Washington Blvd., Chicago, Ill	Student

EDGAR S. NETHERCUT,
Secretary.

ADDRESSES WANTED

In order to have our records of members' addresses complete, we ask that anyone knowing the present address of members listed below to communicate with the Secretary.

Name.	Last Address Given.
James L. Anning	Rice Hotel, Houston, Texas
H. S. Baker	Wolcott, Ind.
Rudolph O. Banaugh	Box 251, Cedar Rapids, Iowa
D. C. Bippus	Curtis Bay Hotel, Baltimore, Md.
B. H. Bryant	Apartado 46, Chichuahua, Mexico
D. H. Cahn	1004 Powers Bldg., Chicago, Ill.
F. S. Callender	2001 16th St., N. W., Washington, D. C.
Harold Cohn	168 W. North Ave., Chicago, Ill.
H. W. Deakman	Lieutenant, 311th Engineers
R. B. Easton	Aberdeen, South Dakota
Arthur L. Evans	223 Leamington Ave., Chicago, Ill.
Roman de la Garza	10619 Longwood Drive, Chicago, Ill.
W. Hess	4442 Dover St., Chicago, Ill.
John Janicki	906 Maple Ave., Oak Park, Ill.
Max Kadin	2550 Potomac Ave., Chicago, Ill.
Willis Leriche	204 Ra Long Bldg., Kansas City, Mo.
C. N. McNeil	1732 First National Bank Bldg., Chicago, Ill.
Miles H. Mann	Teetor Adding Machine Co., Des Moines, Ia.
C. J. Myers	206 E. 13th St., Huntington Beach, California
Chas. W. Naylor	4637 N. Drake Ave., Chicago, Ill.
Vincent Pagliarulo	608 Grace St., Chicago, Ill.
Roger C. Palmer	U. S. S. M. A. Barracks I, Champaign, Ill.
Louis A. Pettibone	Fon Du Lac, Wisconsin
Garibaldi Piccione	501 Fifth Ave., New York City
Peter T. Priestley	6604 Loomis Blvd., Chicago, Ill.
Jerre T. Richards	1323 Emily St., Chicago, Ill.
R. P. Sauerhering	269-608 S. Dearborn St., Chicago, Ill.
R. O. Scholz	921 Fifteenth St., Washington, D. C.
Frank H. Schwartz	4056 N. Lexington Ave., Chicago, Ill.
A. B. Shenk	5138 N. Winchester Ave., Chicago, Ill.
Chas. Shuman	24 W. Elm St., Chicago, Ill.
Owen T. Smith	Box 43, Wilmette, Ill.
James Sorenson	511½ Cramer St., Milwaukee, Wis.
John Stone	Aviation Corps, Ohio State University, Columbus, Ohio
James H. Ticknor	441 Magnolia Ave., Chicago, Ill.
H. M. Trippe	Whitewater, Wisconsin
R. Van Loon	Harvey, North Dakota
Fred Weber	Care of Vacuum Oil Co., Detroit, Mich.
Guy F. Wetzel	6242 Lawrence Ave., Chicago, Ill.
Edward Wilmann	1462 Avenue G, Flatbresh, Brooklyn, N. Y

TECHNICAL SECTION

JOURNAL OF THE

WESTERN SOCIETY *of* ENGINEERS

Volume XXVI | JANUARY, 1921 | Number 1

City Gas of the Future

BY R. B. HARPER, M. W. S. E.

Presented June 23, 1920.

Like many of the great industries, that of the manufacture of gas for use in cities has undergone and will undergo certain changes and improvements. True it is that the maufacture of city gas is one of the oldest of the great industries in this country and perhaps one which has undergone comparatively little change in its essential features. This is in part no doubt due to the fact that manufactured gas has unlike many of the great commodities, been under more or less stringent regulation as to its quality almost since the inception of the business.

While regulation of the quality of any product is desirable, unfortunately, when such regulation is applied by governmental or other agenciés outside of the industry producing the commodity, there is always a certain amount of inertia, indifference and sometimes suspicion which it is necessary to overcome in order to have existing regulations superceded by others which are more suited to the prevailing or future conditions.

It is the purpose of this talk to lay before you some of the factors which have affected the manufacture of so-called "town," "city" or "illuminating gas" in the past and will doubtless have a bearing upon the quality of the artificial gas of the future.

In order to more fully appreciate the situation as regards the city gas of the future, we perhaps should go back to the very foundation of the gas industry and very briefly trace its progress.

EARLY HISTORY

Early in the seventeenth century it may be said that the volatile combustive products from coal were discovered and named "geist" (meaning ghost or spirit) but that no practical application was made of this discovery until about 1792, when William Murdock distilled coal in an iron retort and by conducting the gas thus made through tinned metal tubes, he was able to illuminate his house at Redruth, Cornwall.

Other installations were made and much interest was aroused in the new form of lighting so that in 1812, a Royal Charter was granted

and in the following year the City of London Gas Light Company was established. A few years later, or in 1816, the city gas industry took foothold in the United States at Baltimore, Md., where an ordinance was passed to permit Rembrandt Peale and others to manufacture gas, lay pipes in the city streets and enter into contracts with the City of Baltimore for lighting the streets.

It was quite natural for people, who had previously been dependent upon candles or crude forms of oil lamps for artificially lighting their homes or streets at night, to look upon gas almost solely as an

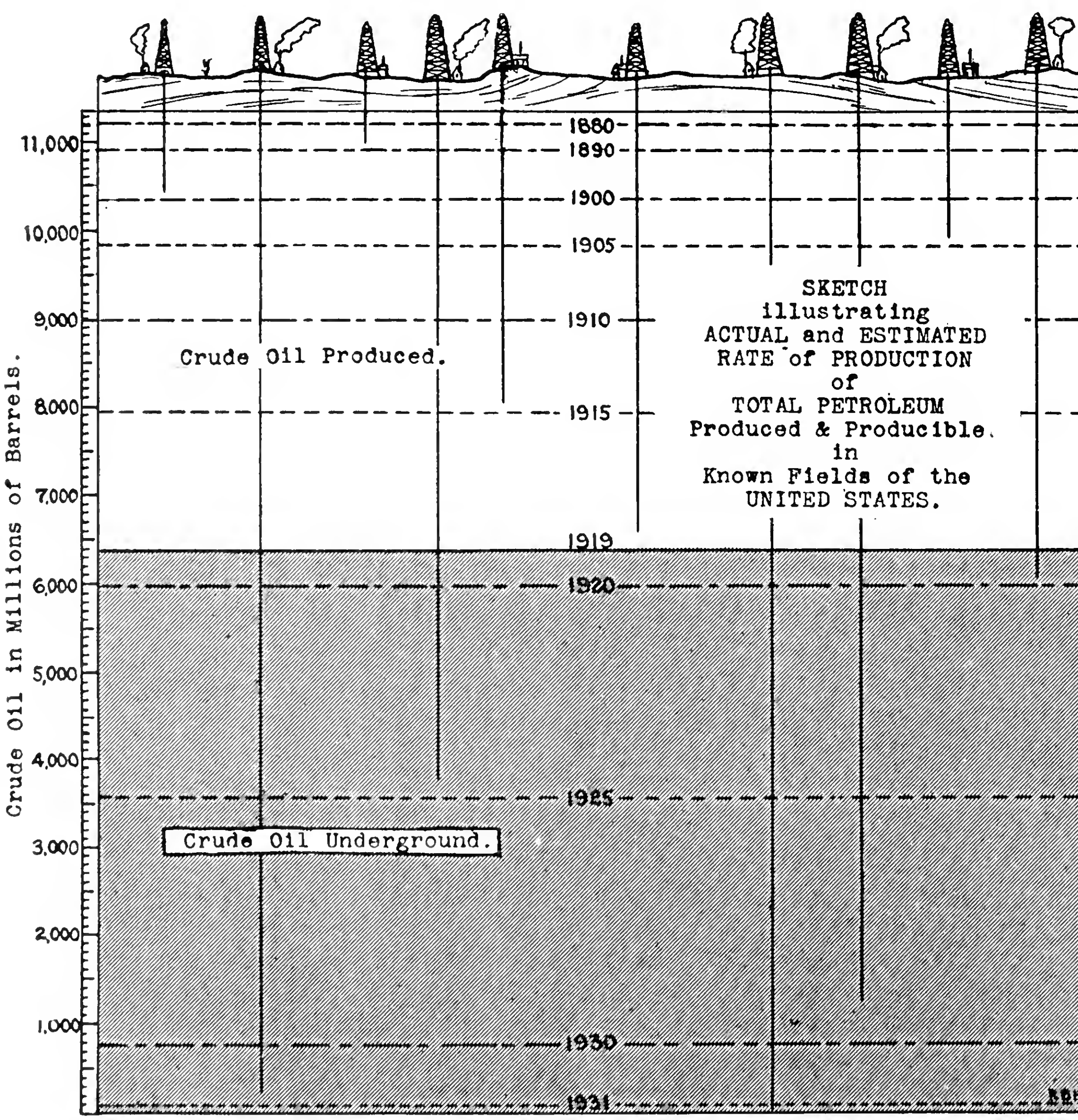


Figure 1

illuminant. It was also to be expected that the lighting value of the new illuminant should be measured by the only "yard stick" known at that time, namely the light given by wax candles. Hence, it was that in the early stages of the development of the industry, the value of city gas came to be measured in terms of its "candle power" or the intensity of light of its open flame burned under conditions as to burner, rate of burning, etc., specified by municipal or other regulatory bodies.

LATER HISTORY

By 1880, Lowe had contributed much to the practical development, in the United States of the carbureted water-gas process, which consists in passing steam through a bed of fuel (usually coke or anthracite, previously heated to incandescence by a "blow" or blasting with air) and mixing in red hot checkerbrick the blue water-gas (consisting chiefly of hydrogen and carbon monoxide) thus produced, with oil-gas formed by introducing and spraying oil upon the hot brick.

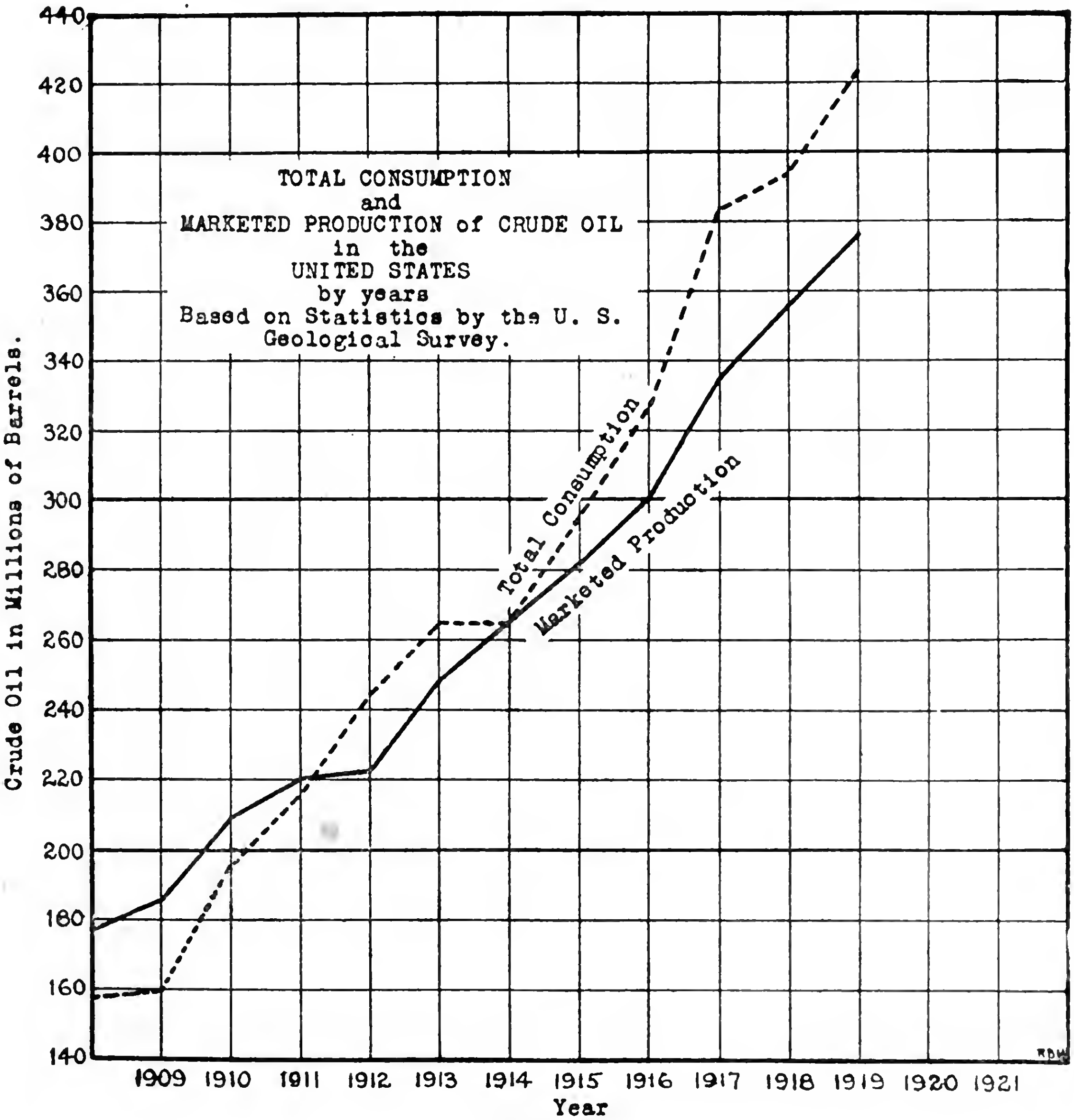


Figure 2.

Both the coal and carburetted water-gas processes were useful in the production of city gases having highly luminous open flames and hence were usually known as "illuminating" or "candle power" gas. These gases have, therefore, been produced chiefly for the characteristic luminosity of their open flame.

CHANGES IN UTILIZATION OF CITY GAS

There has been a gradual but almost complete revolution in gas utilization but practically no change in processes of manufacture of

city gas since the early days of the industry, about one hundred years ago. For about the first 60 or 70 years, city gas was almost solely used for the purpose of lighting houses and streets by means of open or luminous flames which depended for their luminosity upon the fact that the gas contained certain compounds of carbon and hydrogen, derived from rich or bituminous coals or oils which gave out considerable light when the gas was not preadmixed with air before reaching the zone of combustion. In contrast to this, city gas is now almost solely used for the purpose of heating by means of the so-called Bunsen or

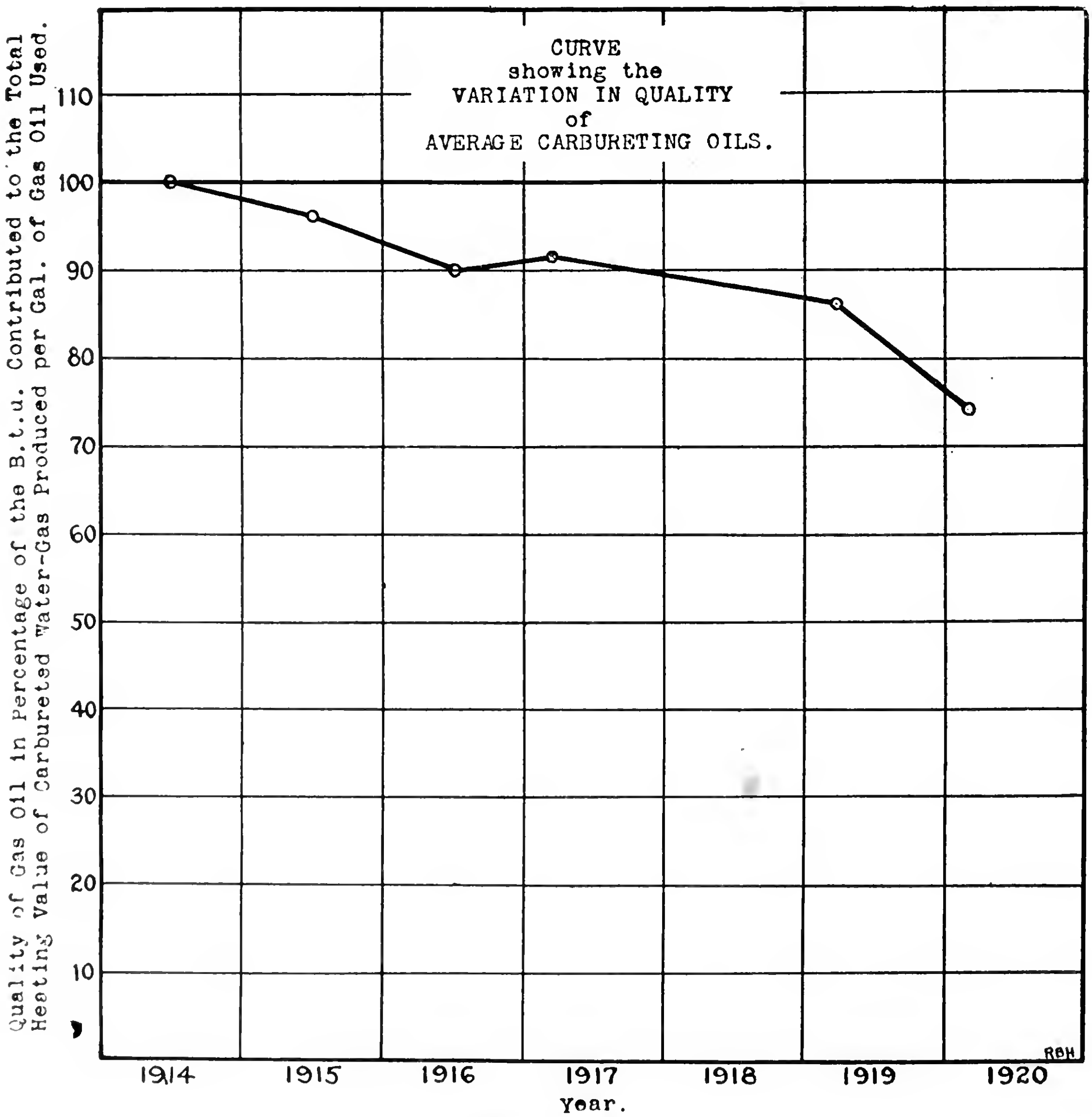


Figure 3.

non-luminous flames. The Bunsen flame depends upon the characteristic of being non-luminous because air is mixed with the gas before it reaches the zone of combustion thereby greatly increasing the rapidity of combustion and concentration and temperature of the flame volume. It is the type of flame now used in almost all gas burning appliances, such as gas ranges, or stoves, water heaters, industrial equipment, mantle lamps, etc.

CHANGES IN REGULATIONS FOR CITY GAS

The change in the nature of the utilization of city gas has resulted in the gradual tendency for regulatory authorities to insert specifications as to heating value in addition to the existing candle power requirements.

In States and municipalities where the utility commissions or city authorities have come to recognize the revolution which has occurred in the use of gas, there has been a tendency to set specifications

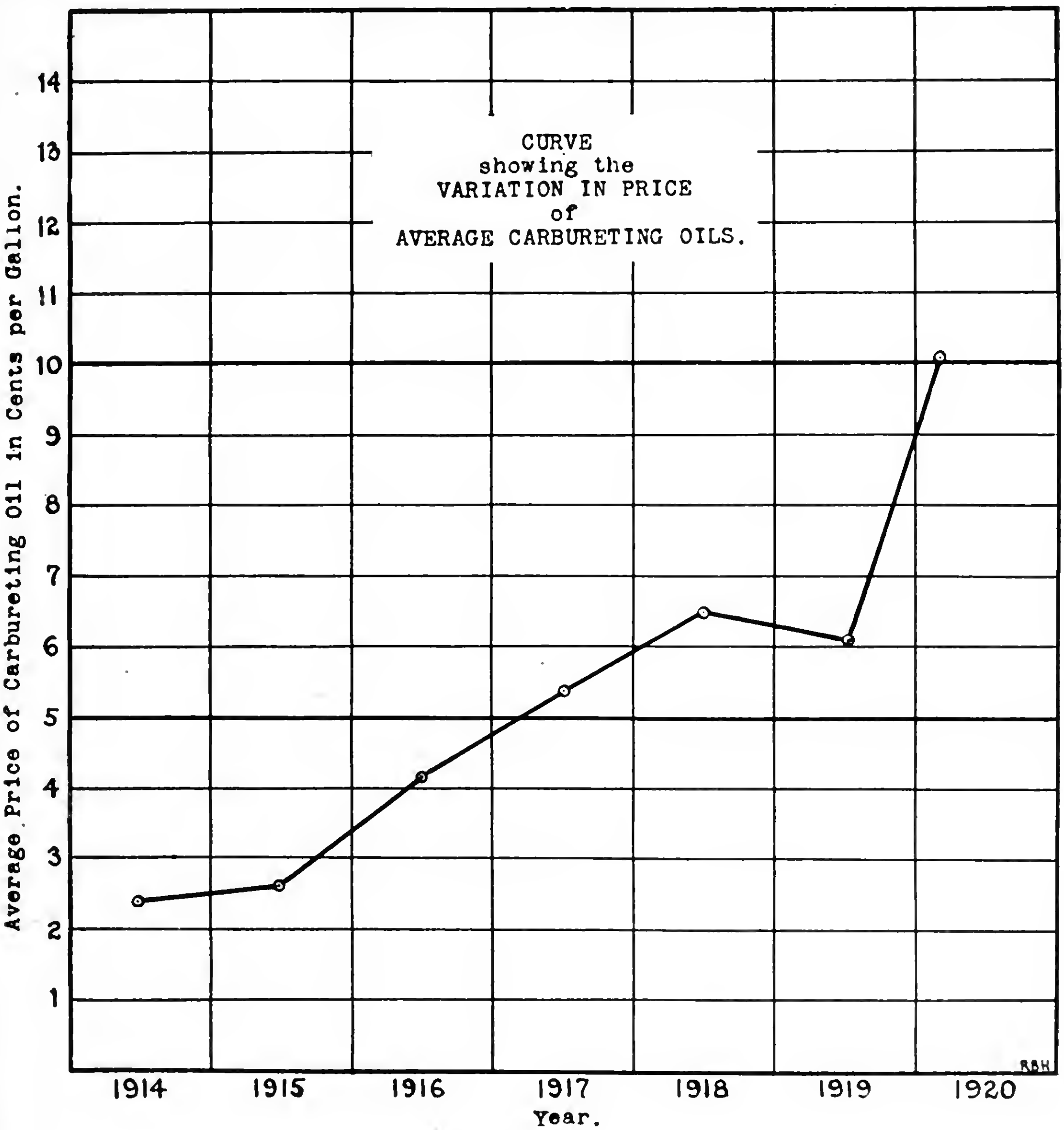


Figure 4.

for the heating value only and to discard the candle power requirements. However, some communities have not as yet been able to overcome the inertia usually encountered whenever an attempt to modernize city gas quality specifications, the necessity of which is perhaps perfectly obvious to an engineer but is unfortunately too frequently looked upon with suspicion by the politician or others upon the regulatory body.

ORIGIN OF HEATING VALUE STANDARDS

In setting requirements, regulatory bodies have somewhat naturally chosen standards which were substantially the heating values of city gas made by processes only intended originally for the production of so-called "candle-power" or illuminating gas giving a high degree of luminosity when burned in open flames. Thus, it has come about that heating value standards have been set in accordance with what happened to be the heating values of city gas as then made and not on the basis of processes which were designed to economically utilize the gas making materials, as provided by Nature, in such a

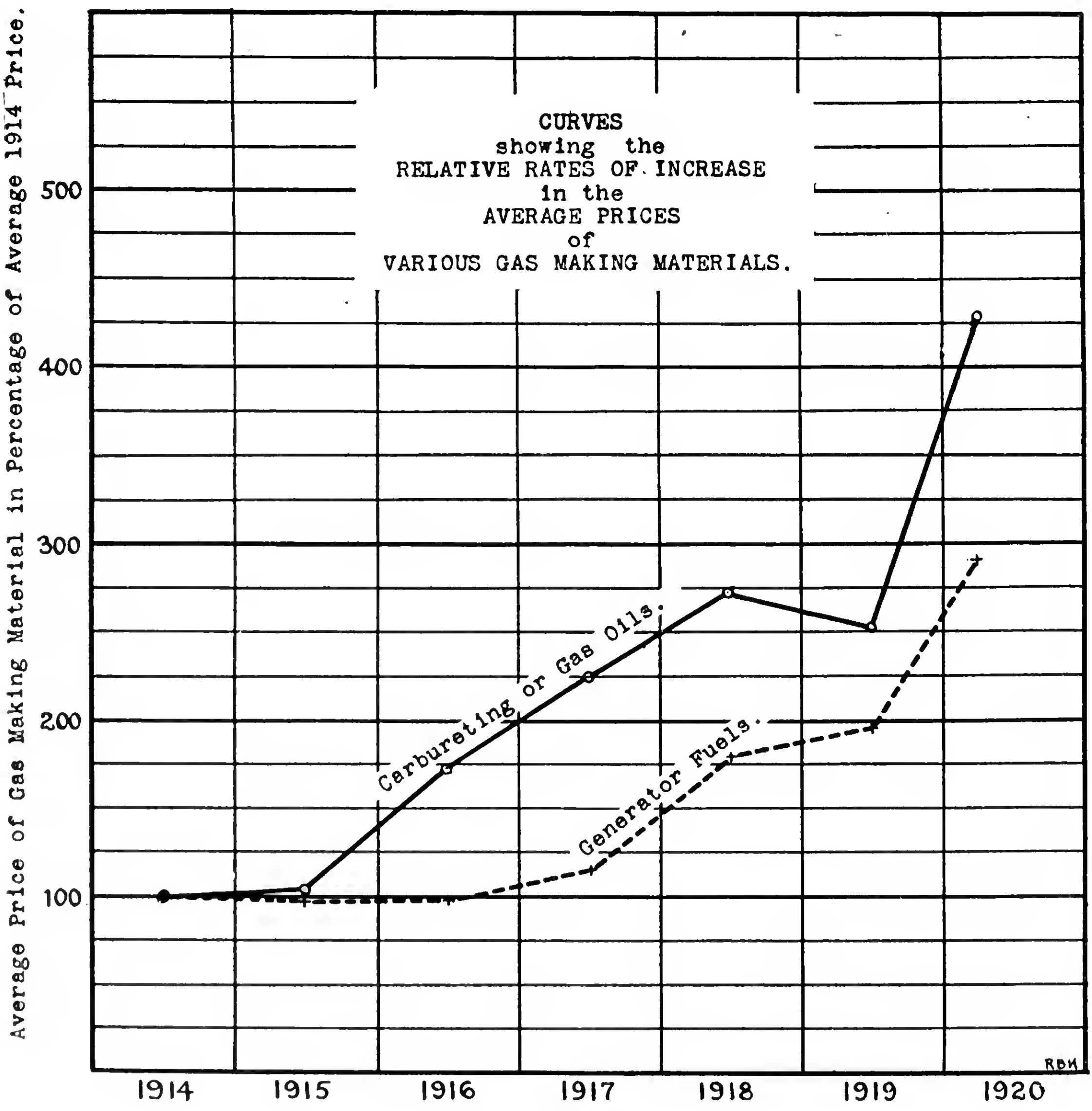


Figure 5.

manner as to produce the greatest total heating value per unit cost of gas making material.

GAS MAKING MATERIALS

Nature provides us with coal and petroleum, which together with products derived from these, constitute the principal materials from

which city gas can be manufactured. While coal as gas making material is found in relative abundance in the United States, we are apparently producing our known petroleum resources at an alarming rate and consuming petroleum and its products at even a much greater rate as shown on Figs. 1 and 2.

While these charts indicate conditions which may be unduly alarming as to the future petroleum situation, we should nevertheless take heed and see to it that we make the most economic use of our remaining available petroleum even though our oil resources are much greater than what we now estimate them to be.

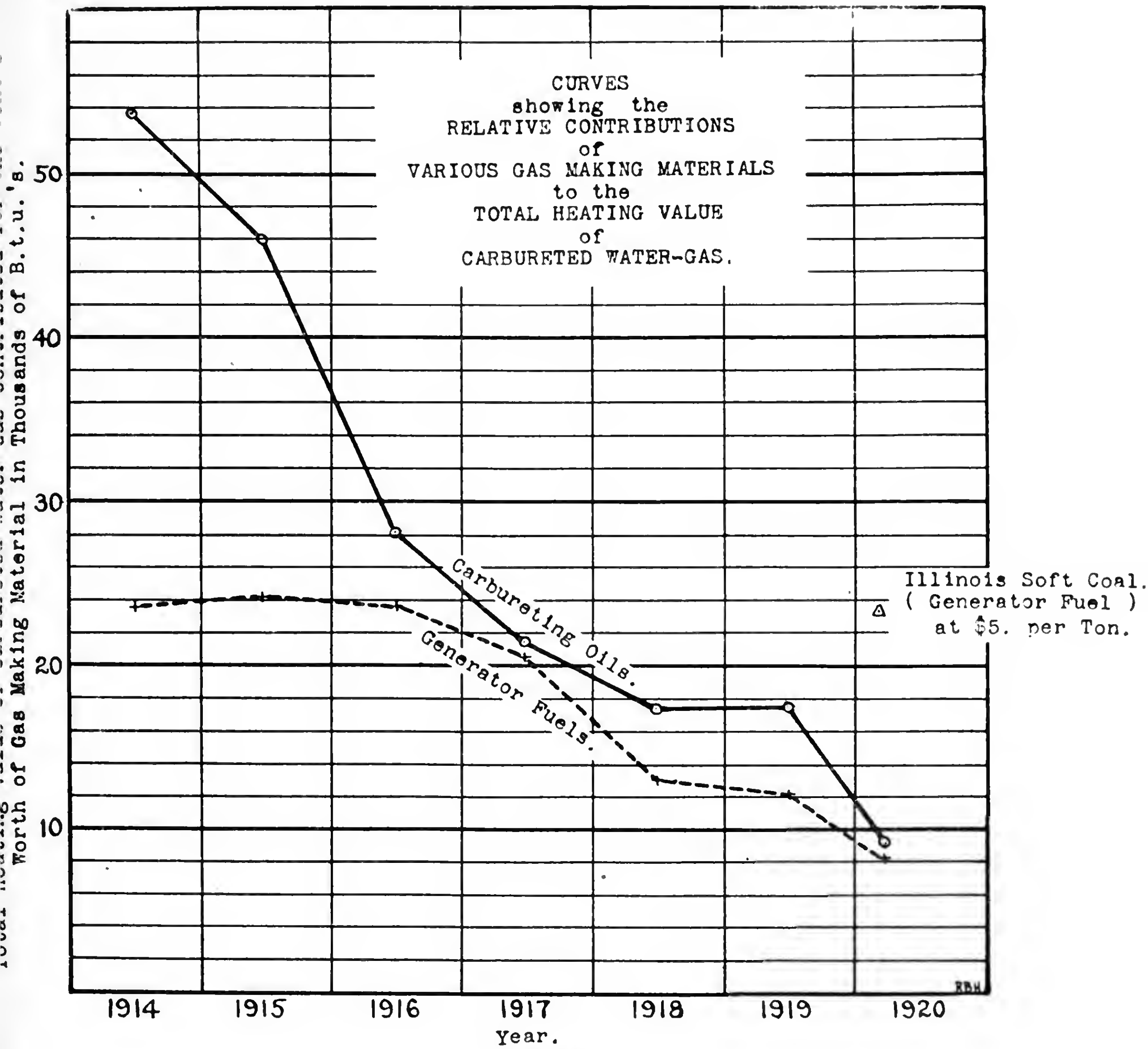


Figure 6.

ECONOMIC USE OF GAS MAKING MATERIALS

Coal: In Bulletin No. 102, Part 4, of the Smithsonian Institute, entitled "Coal—The Resource and Its Full Utilization," a balance sheet is given on page 9 which shows that one ton (2,000 pounds) of bituminous coal valued at $1.13 at the mine could be made to yield coke, gas, ammonium sulphate, benzol and tar worth $15.59. The bulletin also states that we have yet underground about 1,500,000,-

000,000 tons of bituminous coal and that about 9,200,000,000 tons have been mined.

So far as bituminous or gas-making coals are concerned, the resource may be considered large provided the standards of heating value for the gas produced do not unnecessarily restrict the selection of coals available for gas making.

From the standpoint of gas manufacture, by-product ovens appear to be the economic solution of the problem of producing the useful materials derived from the constituents of bituminous coal, provided

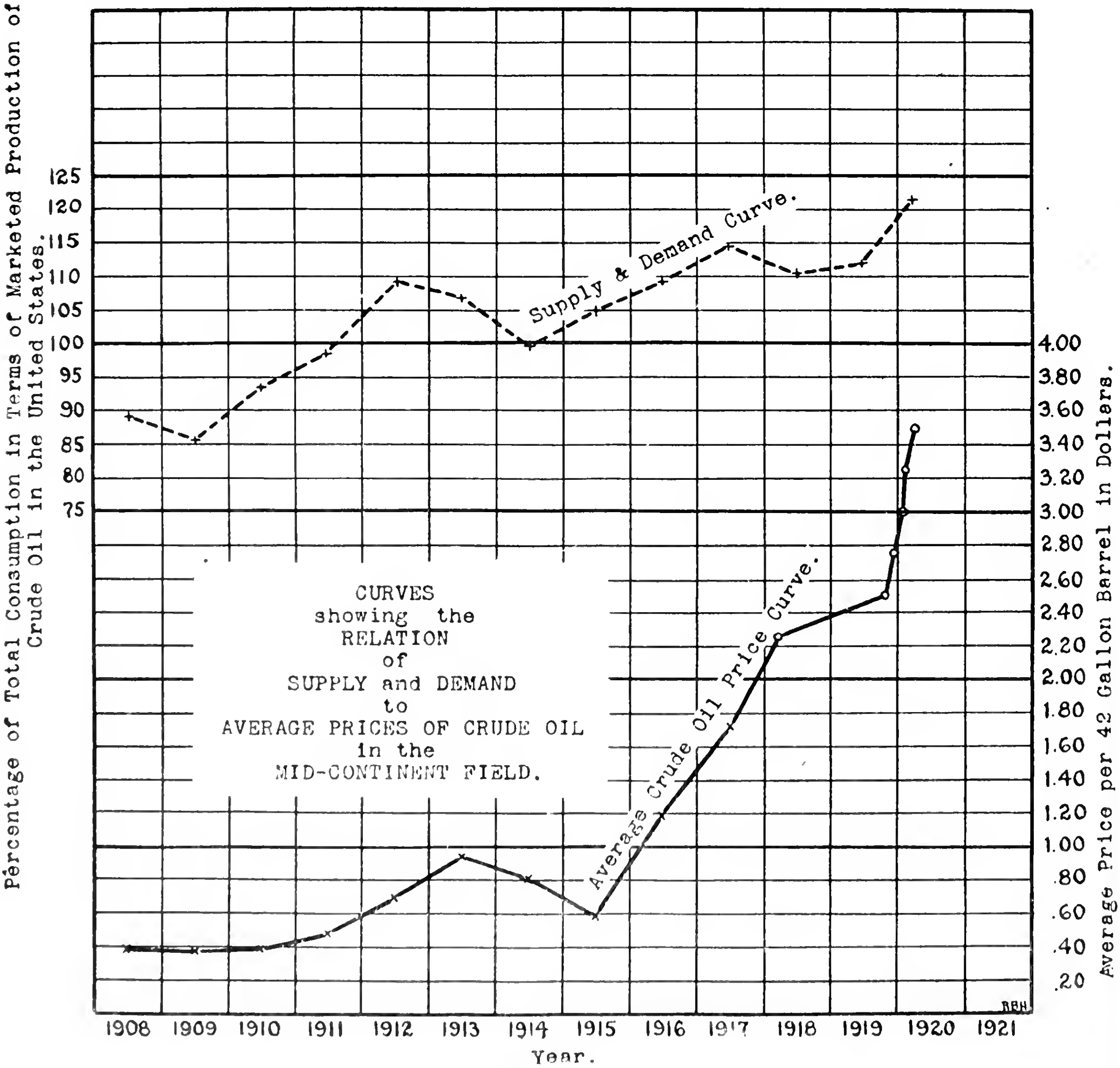


Figure 7.

the solid product of coke so obtained is converted into water-gas and the latter mixed with the surplus or available gas from the ovens, for use as city gas. From other standpoints, the by-product oven makes possible the recovery of certain by-products from which are derived chemicals, disinfectants, drugs, dyes, explosives, fertilizers, medicines, motor fuels, solvents, etc., which are so necessary and useful to society.

Petroleum: Petroleum, in sharp contrast with coal, as a gas making material, has already been shown to be in great need of conservation.

In the Smithsonian Bulletin No. 12, Vol. 1, entitled "The Energy Resources of the United States; A Field for Reconstruction," the statement is made on page 75 that—

> "The use of gas oil, a high grade fuel oil, in the manufacture of city gas represents a practice largely unjustifiable on the basis of resource economy."

Carbureting or gas oils have, due probably to various processes which are "cracking" or converting increasing amounts of such oils into gasoline or motor fuels, shown considerable decreases in value for

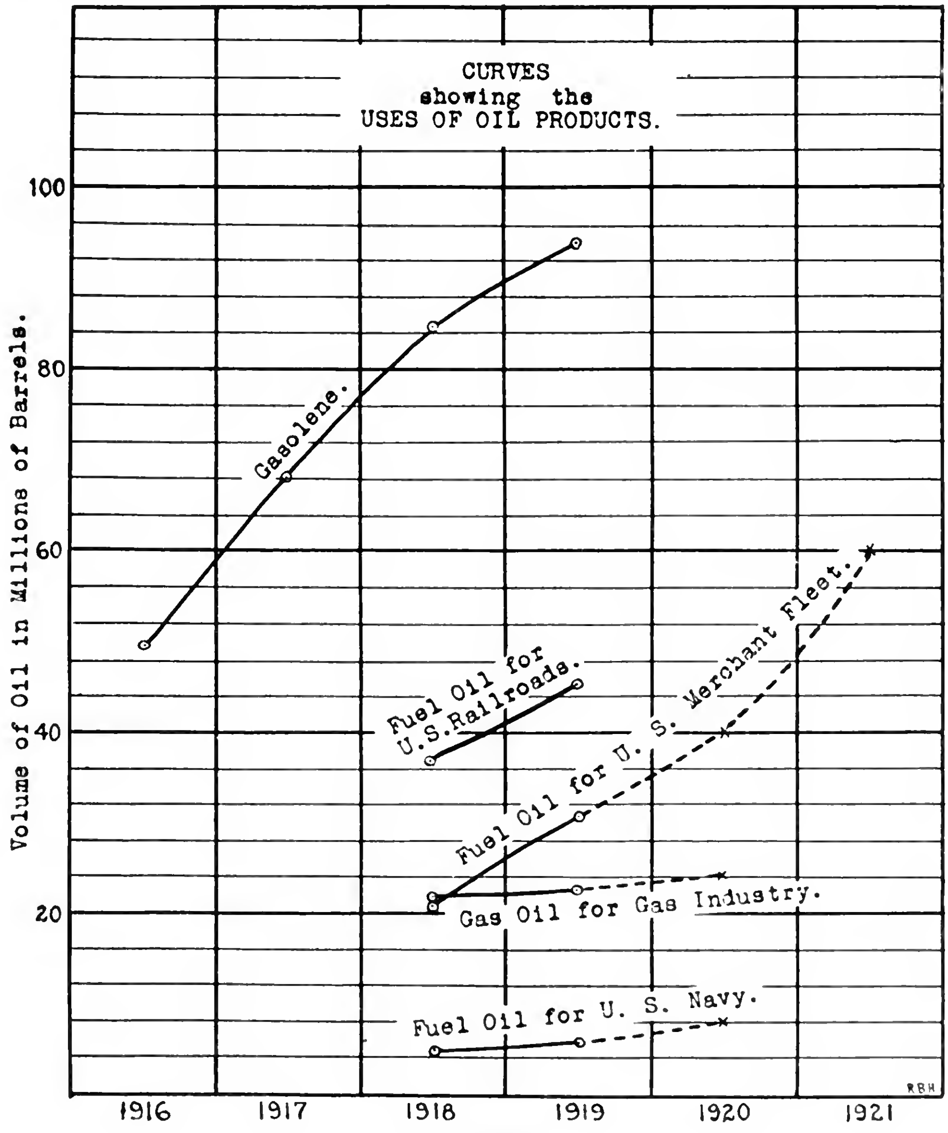


Figure 8.

gas making. An illustration of this variation in quality is shown in Fig. 3.

Fig. 4 illustrates the variation and steady increase in average prices of carbureting or gas oils, while Fig. 5 gives the relative greater increase in average price of gas oils as compared with the average price of generator fuels.

In Fig. 6 we have the effect of the deterioration in quality combined with increased prices of average carbureting oils, as compared

with those of generator fuels, upon the relative contributions of the two gas making materials to the total heating value of the gas produced. From these curves it will be readily noted that the gas oils are

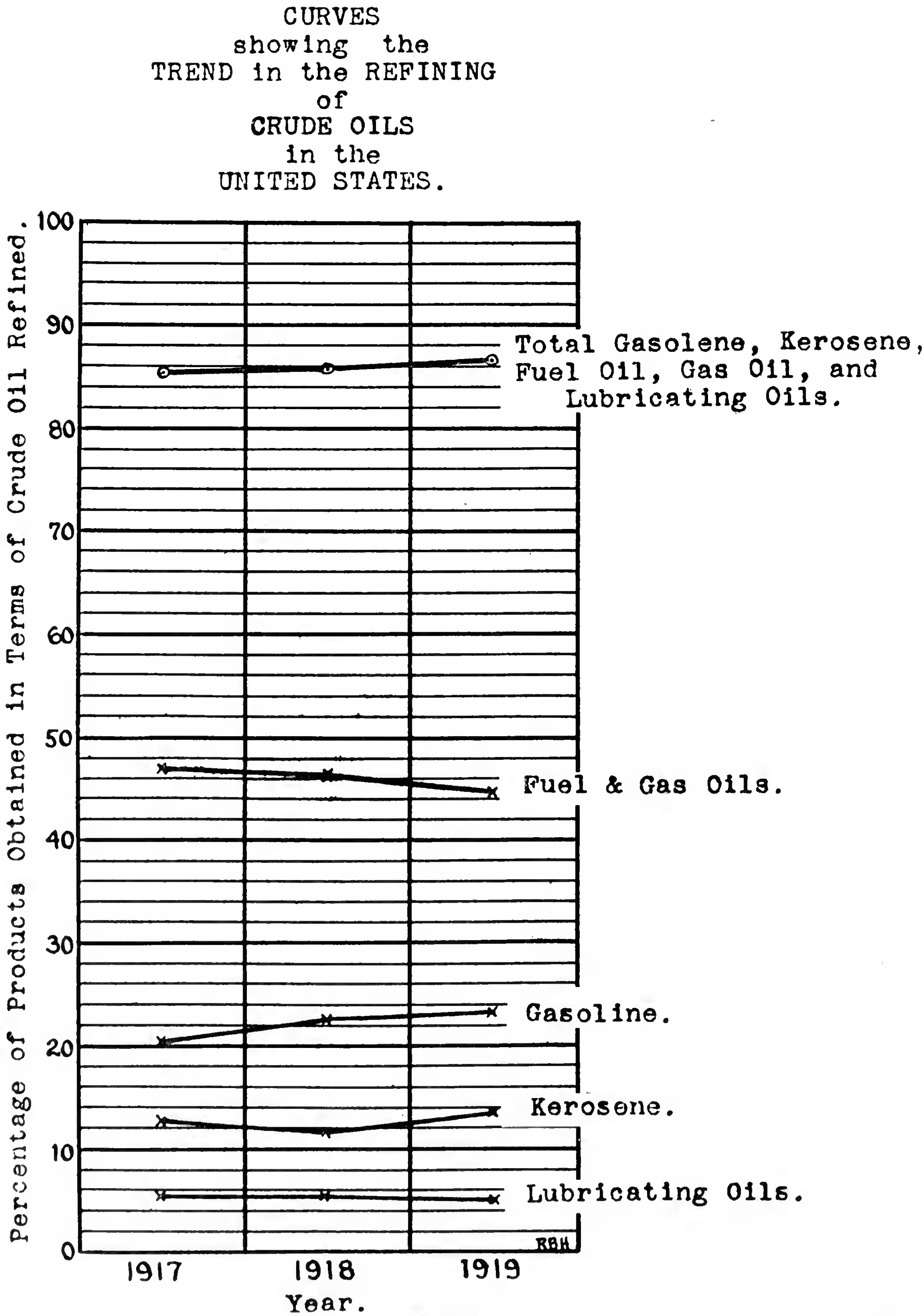


Figure 9.

now about the same or of less value for carbureting than are generator fuels.

These charts show that we have now practically reached a condition wherein one cent's worth of gas oil does not contribute as much to the total heating value of gas produced as does one cent's worth of generator fuel, and hence that gas oil no longer fulfills its original function of being a carbureting agent.

RELATION OF PETROLEUM SITUATION TO THE GAS INDUSTRY

It was shown in Fig. 2 that our total consumption has exceeded our marketed production of crude petroleum in the United States for every year since 1914. This has no doubt been a strong factor in the constantly increasing price for crude oil.

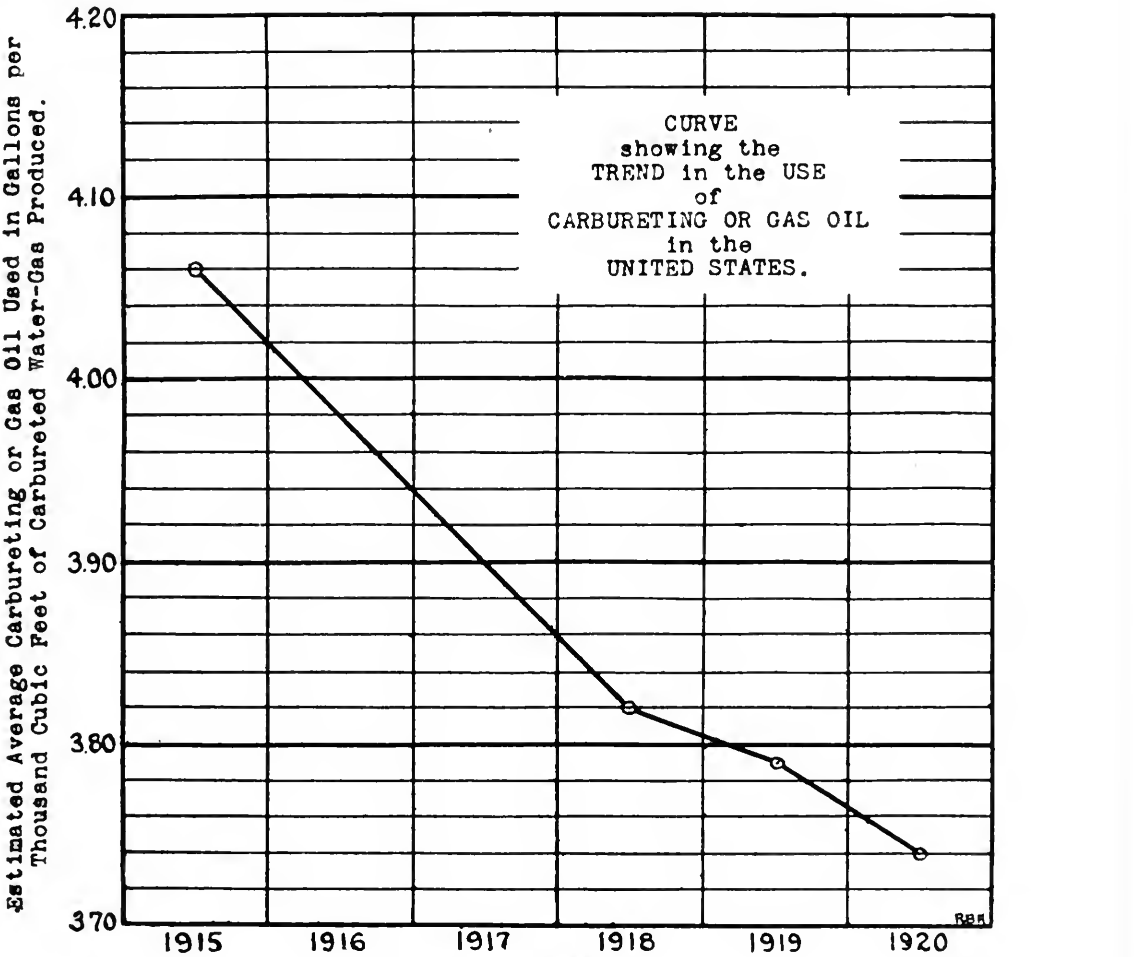


Figure 10.

Fig. 7 shows that the price of oil apparently varies in accordance with the ratio of the total consumption to the total production of crude oil in the United States.

For sometime there has been a very serious shortage in gas oil due to a number of factors.

The utilization of fuel oils, in which class gas oil is placed by the oil industry, has been increasing at a much greater rate in various industries than has the consumption of carbureting or gas oils. This condition as shown in Fig. 8, shows that gasoline, some of which is made from fuel and gas oils, as well as fuel oils consumed by railroads, and the merchant fleet are in relative greater demand than gas oils by the gas industry.

The oil refining business is apparently adjusting itself to the greater demands for gasoline by making inroads into the portions of

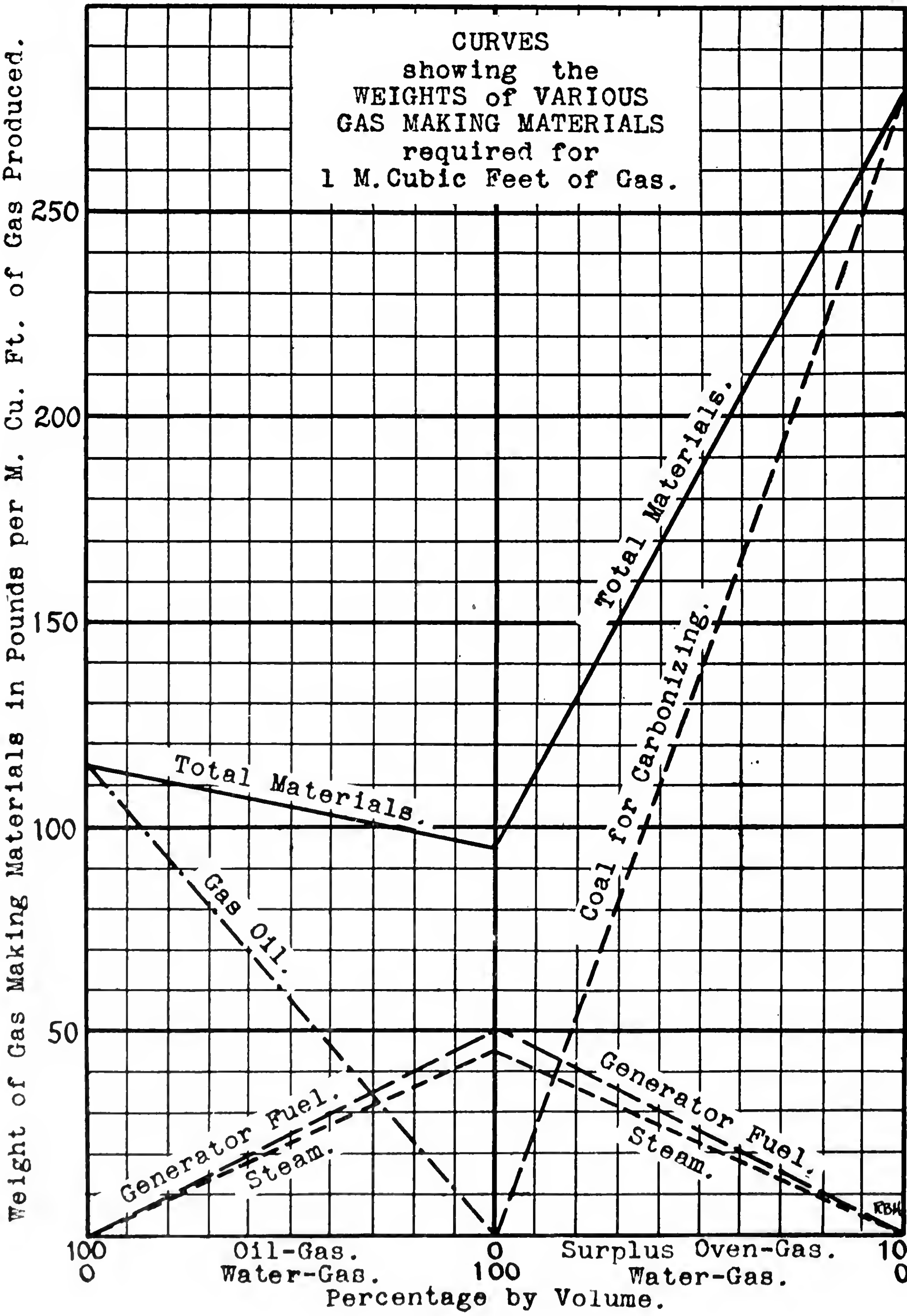


Figure 11.

crude oil formerly refined into gas and fuel oils. Thus Fig. 9 shows that while more refined products, such as gasoline, kerosene, gas and fuel oil and lubricating oil, are being secured each year from crude

petroleum, the tendency in oil refining seems to be to produce more gasoline and kerosene at the expense of the gas and fuel oil portions.

The petroleum situation has undoubtedly had some affect on the amount of oil used in each one thousand cubic feet of carbureted water-gas produced in this country. Fig. 10 shows that the estimated average carbureting or gas oil used will probably show a decrease from about 4.06 in 1915 to about 3.74 gallons per M. cu. ft. in 1920.

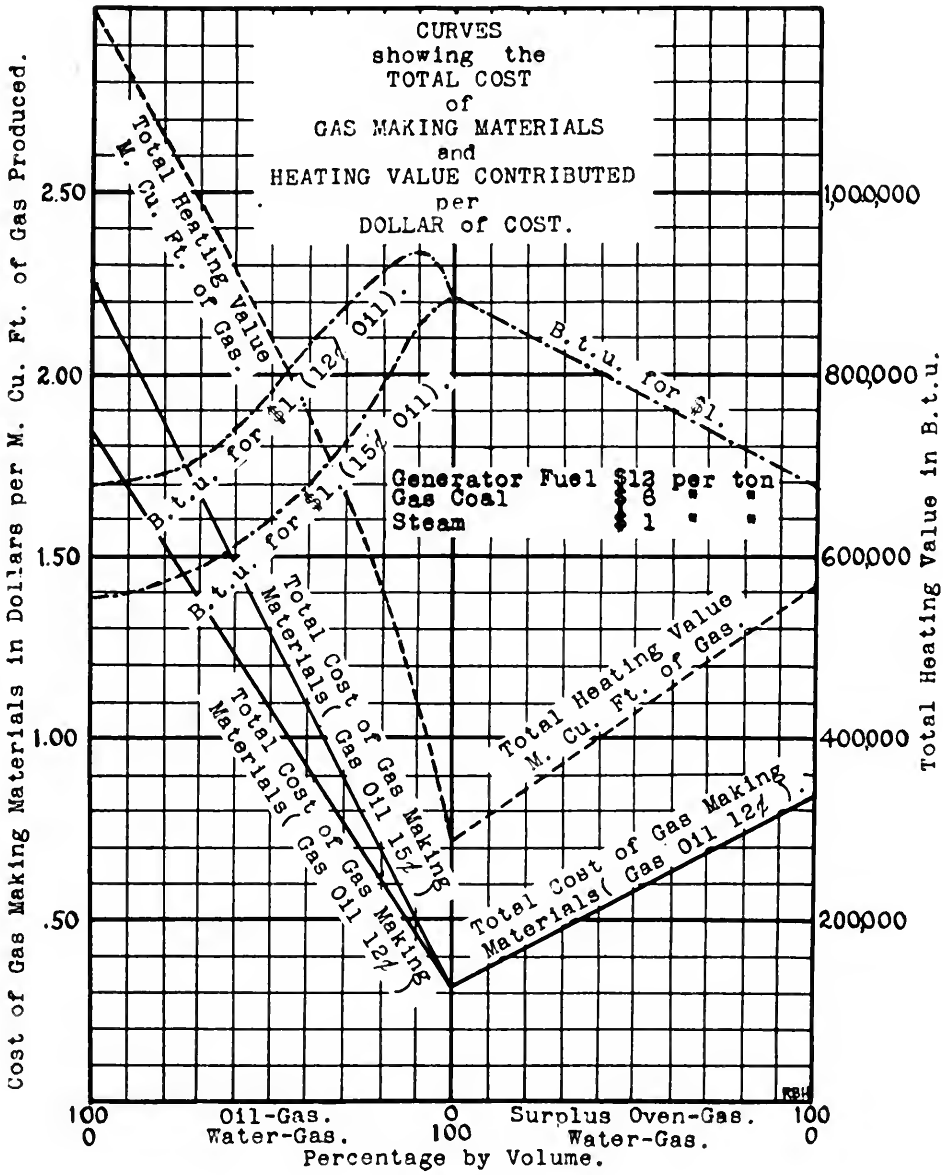


Figure 12.

TREND IN HEATING VALUE STANDARDS FOR CITY GAS

The general trend in standards for city gas has been toward lower heating values which have made possible the necessary conservation of oil and the more economic use of coal for the manufacture of gas.

There has been a tendency in some communities to retard what appears to be the necessary trend in the heating values of city gas in order to secure more economical utilization of gas making materials,

but, in general, regulatory bodies are gradually revising standards which reduce the use of oil and require a greater conversion of the coal into gas and by-products.

Recently the Dominion of Canada adopted a heating value standard of 450 British thermal units per cubic foot for city gas and in England, in order to conserve fuel, the Fuel Controller recommended to the Board of Trade that gas companies be compelled to make the greatest possible use of coal for gas production by requiring them to produce gas having a heating value of not greater than 425 B. t. u. per cu. ft.

CITY GAS OF THE FUTURE

Having covered briefly the various conditions of the past and present, we can now consider what appears to be the trend in the manufacture of the city gas of the future.

In order to aid in this consideration, we might first refer to Fig. 11, which shows the various approximate weights of gas making materials ordinarily required for each one thousand cubic feet of oil-gas, by-produce oven-gas; blue water-gas and various mixtures of the first two with the last named gas. In Fig. 11, it will be seen that the total pounds of actual gas making materials required per M. cu. ft. of gas varies from about 115 lbs. of oil for oil-gas and about 280 lbs. of gas coal for surplus oven-gas down to a total of only about 95 lbs. of coke and steam for manufacturing straight blue water-gas.

In each case we find that straight blue water-gas is the most economically produced as regards weight or cost of gas making materials required for the production of one thousand cubic feet of the gas.

Fig. 12 illustrates that as lesser quantities of oil-gas are present in mixtures with blue water-gas, the total heating value of the carbureted water-gas is somewhat higher than might be expected. This is due to the oil-gas at lower concentrations being of higher value than at high percentages of oil-gas mixtures with blue water-gas.

It should also be noted from Fig. 12, that when the oil costs as much or less in cents per gallon than the generator fuel costs in dollars per ton, the carbureted water-gas of approximately 440 B. t. u. per cubic feet total heating value has the most contributed to its total heating value per dollar's cost of gas making materials, but that when the oil is more costly, straight blue water-gas without any oil is the most economical from the standpoint of the contribution to the total heating value per dollar's cost for the gas making materials.

Straight blue water-gas, according to Chart 12, contributes about 880,000 B. t. u. per dollar's cost of gas making materials, whereas with with oil at 12 cents per gallon and gas coal at $6 per ton, straight oil gas and by-product oven surplus gas contribute only about 680,000 B. t. u. to the total heating values of respective gases, per dollar's cost of gas making materials.

From the standpoint of the economical use of possible gas making materials, it appears that in the future city gas may be made as far as possible by carbonizing gas coal in a by-product oven and using the coke so produced in water-gas machines to make a straight blue water-gas to be mixed with the surplus oven-gas. Such a gas would consist

of about 80 to 85 per cent of the blue water-gas and 15 to 20 per cent of surplus oven-gas giving a mixed gas having a total heating value probably somewhat less than 350 B. t. u. per cubic foot.

Such a city gas of the future would permit the economical utilization of coal and the maximum production of gas therefrom on the basis of gas making material costs. It would also make possible the continued use of the present equipment in water-gas machines with the exception that oil would not be employed in the process.

The city gas consisting of the blue water-gas-coke oven-gas mixture should be very stable in quality, burn well and when consumed in burners properly adjusted or set for its use, should give good service to the consumers.

The city gas of the future, such as has been described, will probably come gradually but nevertheless surely if the present economic trend of conditions as regards gas oil continues. Furthermore, if the oil situation follows its present trend, the city gas of the future may be determined more by what it is possible to manufacture from the available gas making materials than by any other consideration such as the most heating value per unit cost of gas to the consumer.

Its coming will necessitate changes in the total heating values of gases supplied in cities and hence in the standards of quality specified by the regulatory bodies.

It will cause many problems in an industry which is said to represent an investment of about $5,000,000,000 and a service of nearly 50,000,000 people with fuel and light, but no doubt all of these questions will be solved as they occur. There will be added investments in plant and distribution equipment necessary in some cases and probably more or less readjustments of some gas appliances in nearly all cases as the evolution in the total heating values of gas causes the change from present city gases of 500 B. t. u. to city gases of the future having perhaps less than 350 B. t. u.

Each problem will require its own solution and in each case there will no doubt be made every effort to best serve the interests of the consumer, the gas company and all parties concerned.

ISHAM RANDOLPH
1849-1920

MEMOIR

ISHAM RANDOLPH

The subject of this sketch was born at "New Market," the family home of the Randolphs in Clark County, Virginia, on March 25, 1848.

He was the son of Robert Carter Randolph, M. D., and Lucy Nelson Wellford, being descended on both his father's and mother's sides from families whose names since Colonial times have been written largely in the history of his country. He was the sixth son in a family of twelve children. Reared in a section of the State that was devastated by the Civil War, but too young to enter the strife with four of his brothers who rendered distinguished service to the South in their several capacities, he was yet sufficiently old for the events of that tragic epoch, and the reconstruction period that followed, to make a lasting impression upon his life and character. To that experience, coupled with his subsequent life and professional activities in so many widely separated sections of this country, may be attributed in great measure his public spirit and the broad-minded, staunch patriotism that were among his most distinguishing characteristics.

When the war closed he entered whole-heartedly with his father into the rehabilitation of the family estate, but soon realized that the changed conditions of living necessitated branching out into other fields of action and at the age of 20 he entered the service of the B. & O. Railroad Company with a party engaged in the location and construction of the Winchester & Strausberg Railroad, beginning thereby the career of Civil Engineer, which he followed so successfully to the close of his life.

In succeeding years he was levelman and transitman on surveys for the Washington & Ohio and the Lehigh Valley Railroad, respectively, and in 1872 re-entered the service of the B. & O., locating that Company's Chicago Extension from Syracuse to Chicago, building 27 miles of the line and the shop terminals in Chicago.

In 1876 he entered the service of the Scioto Valley Railroad, becoming Roadmaster of that line, and in 1880 came to Chicago as Chief Engineer of the Chicago & Western Indiana Railway. With that Company he had a large experience in building railroad terminals, freight houses and yards.

In 1885 he opened an office for general engineering work in Chicago, but in 1886 entered the service of the Illinois Central Railroad, locating and building that Company's line from Chicago to Freeport and to Dodgeville.

In 1888 he resumed his general practice in Chicago and acted as Consulting Engineer for the Union Stock Yards and Transit Co., and for the B. & O. Railroad Company in obtaining an independent entrance into the city.

In June, 1893, he was elected Chief Engineer of the Chicago Sanitary & Ship Canal (The Chicago Drainage Canal). This work had just been started and he directed it for the entire fourteen years of its construction period.

This Canal cost about sixty millions of dollars and, prior to the construction of the Panama Canal, was the largest artificial channel for water that had ever been built. Cutting through a thickly popu-

lated district of the city, intersecting streets, railroads and public utilities, with innumerable governing boards and bodies to deal with, it was a work requiring not only engineering ability, but likewise tact and diplomacy of the highest order. The work was carried to completion with distinguished success, bringing the name of its Chief Engineer into international prominence, and when in 1907 he resigned, purposing to enter upon a wider field of activity, he was prevailed upon to continue as Consulting Engineer by the Board of Trustees, which unanimously passed a resolution most highly appreciative of the services which he had rendered, a portion of which is quoted herewith:

> "Words can but feebly express the value of his service both to science and to humanity, but, as a slight token of our esteem, it is hereby
>
> RESOLVED, by the Board of Trustees of the Sanitary District of Chicago in regular meeting assembled this 24th day of July, 1907, that we here record our high appreciation of the long and faithful services of Isham Randolph, as Chief Engineer of the Sanitary District, of his pre-eminent abilities and of the fine qualities of mind and heart which have endeared him to all who have had the good fortune to come into close personal relations with him. We regret the loss of the services of Isham Randolph as Chief Engineer, and rejoice that, as Consulting Engineer, his skilled advice will still be available for the completion of the great work with which he has been so long and so closely identified."

For his accomplishment in constructing this Canal, he was awarded a gold medal by the Paris Exposition of 1900.

He was appointed by President Roosevelt on the Board of Consulting Engineers for the Panama Canal, and was one of the five members of the Board whose minority report was accepted by the President and Secretary of War, approved by the Panama Commission and adopted by Congress. The Canal was constructed in accordance with the recommendations of that minority report and subsequent experience demonstrated conclusively the wisdom of its adoption.

In 1908, President Roosevelt invited him to be one of six engineers whom he wished to have accompany President-elect Taft to Panama to consider "Whether or not there is any reason to change the plans upon which we are working." This Board of Engineers submitted its report to the President on February 16th, 1909, unanimously upholding the plans for the lock canal across the Isthmus.

He designed and built for the Queen Victoria Niagara Falls Park Commission the "Obelisk" dam above the Horse-Shoe Falls. This dam was built upright, on end, on the bank of the river and then tipped over into the stream. It accomplished its purpose.

He was Chairman of the Internal Improvement Commission of Illinois, with plans for five-hydro-electric power plants developing 140,000 H. P. This was a link in the Lakes to the Gulf Deep Waterway, for which the people of the State of Illinois voted twenty million dollars in bonds. He was a member of the Illinois State Conservation Commission charged with the duty of examining and reporting on the conservation of the Natural Resources of the State.

He was a member of the Rivers and Lakes Commission of Illinois, which was, in effect, a State Department of Public Works with a jurisdiction over the Rivers and Lakes of the State.

He was a member of the Chicago Harbor Commission, which made an exhaustive report upon the plans for a lake front harbor in

Chicago. He made an engineering study, report and plans for a commercial harbor for the city of Milwaukee, Wisconsin.

He was Consulting Engineer for the City of Baltimore, Md., on track elevation work, and was employed by the City of Toronto, Canada, in the same capacity. He served the City of Toronto, Canada, as a member of its Water Supply Commission, which made complete plans for a new water supply and water works system in the City.

He was Consulting Engineer for the Little River Drainage District of Cape Girardeau, Missouri. In this capacity the drainage of 500,000 acres of land was planned with his counsel.

He was Chairman of the Florida Everglades Engineering Commission, reporting to the State of Florida on the drainage of swamp lands in the Everglades. He personally made a contract with the State for this work, and employed the other members of the Commission. The report has been completed, submitted to the Governor and made public.

This brief summary of his professional activities illustrates the character of his practice and falls far short of its range. The honorable and important duties performed by him as Consulting Engineer are not recorded, and in some cases were in the nature of confidential advice. He was regarded as an authority, and as such was consulted by men of all degrees, including Presidents of our Nation.

In recognition of his attainments, the University of Illinois, on June 15th, 1910, conferred upon him the degree of "Doctor of Engineering," and he was the recipient of the degree of "Doctor of Commercial Science," from the Washington and Lee University, of Virginia.

In February, 1913, "The Franklin Institute of the State of Pennsylvania," Philadelphia, Pa., conferred upon him the "Elliott Cresson Medal," the highest award in the gift of the Institute, in recognition of "Distinguished Achievement in the Field of Civil Engineering."

He was a:

Member of the American Society of Civil Engineers.

Member of the American Institute of Consulting Engineers.

Member of the Western Society of Engineers for more than thirty-nine years, and its President during the year 1892.

Member and Past President of the American Association of Engineers.

Fellow of the Royal Society for the encouragement of Arts, Manufactures and Commerce.

On June 15th, 1882, Mr. Randolph married Miss Mary Henry Taylor, daughter of Capt. George Edmund Taylor, of Lewisberg, West Virginia.

By this marriage he had three sons: Robert Isham, a member of the firm of Isham Randolph & Co., Consulting Engineers, Chicago, who served in France as Major, commanding the 535th Engineers; Oscar deWolf, Rector of St. Mary's on the Highlands, Birmingham, Ala., who served in the World War as a Major in the Machine Gun Corps of the 10th Division; and Spottiswoode Wellford, an engineer and manufacturer living in Baltimore, Md.

Mr. Randolph's marriage was one of those peculiarly happy unions that furnish a man with inspiration and incentive to high endeavor. The hospitality and charm of his home were proverbial.

When war was declared with Germany, Mr. Randolph was chosen to the office of President of the Citizens Unit of the 108th Engineers and immediately interested himself in organizing that regiment, which was very early in the field and rendered gallant service. When that regiment departed for the scene of war, Mr. Randolph made it an address, which he closed with the following words:

> "Soldiers, you are learning discipline in the hard school of war. Let that discipline also rule your moral conduct and when in the heat of combat you are tempted to deeds of vengeance, remember that mercy is one of the highest attributes which God has given to man; live it and deal it to a fallen foe as you would have mercy meted to your own souls. Go men of the First Regiment of Illinois Engineers and may the God of battles, the God of the whole earth, lead you on to victory and enduring peace."

General Robert E. Lee is quoted as saying: "Duty is the noblest word in the English language." Mr. Randolph's life was characterized by that same high sense of duty to his religion, his country, his family and his friends. One of those friends of many years standing writes of him: "He had the quality of friendship in an unusual degree and the faculty of emphasizing the good traits of his friends and of forgetting qualities that were not favorable. He stands in my memory as a good man and true, one who loved his fellows and won their love and my regard for him as such rises above his material accomplishments. I recognize his eminence in his profession, but in my thoughts I dwell on his character as a man and the influence of his life upon his fellow engineers and especially the younger and rising generation of the profession."

Mr. Randolph is known to have made the statement that his education, both general and technical, was acquired in the school of experience. Nevertheless, his acquaintances knew him as a man of letters, with a liberal education obtained through a wide range of reading and discriminatingly stored in a retentive mind. One could not fail to observe this in his speech and in his writings. It was particularly noticeable that he drank deep at the fountain of highest knowledge, the scriptures which are God's words to man, and his conversation and written words were full of quotations from the sacred book, some of them direct and exact, others indirect and clothed in his own language, all bearing fruit in his expressed thoughts and actions. His knowledge, like his education, was general and comprehensive. Being a fluent talker, possessing a wealth of illustration, with an unfailing stock of humor, he was always in demand where a spokesman was needed and was able to charm and win the friendship of his hearers. This resulted in frequent demand for him to speak on his feet, and yet he was perhaps at his best when talking to one or to a few of his friends, seated in some quiet corner. Whatever might be the pressure of imperative affairs, or the pre-occupation of his mind by anxious thoughts, he would cheer a friend by a few minutes conversation or even by a passing word, and this was because he loved his neighbor.

Mr. Randolph's busy life did not permit him to "write a book," but as he had opportunity, or occasion demanded, he would write briefly on some particular subject, and these short articles, some of them worthy to be considered classics, are scattered in newspapers, society transactions and in the possession of friends. If these could be gathered and edited in a volume (a task which it is hoped some one

will undertake) it would prove a treasure which would reflect the character of the writer.

With his versatile ability, his writings were not confined to prose. With all of the extremely practical side of his nature in connection with his chosen profession, Mr. Randolph was a man of a truly poetic instinct. Without laying claim to the gift of the muse, he used his talent happily and wrote many small poems of merit to the pleasure of himself and friends.

This sketch cannot be more fittingly closed than by a quotation from one of his own poems, which details those qualities of "A Gentleman" of which his life was the living exemplification.

"A gentleman, I deem to be a man,
    A manly man, and true,
With courage high for every deed
    A manly man should do.

A man who loves the golden rule,
    Who loves his fellow man,
Unselfish in his aims and hopes,
    Built on a generous plan.

A man of force but self control,
    Of deeds, not words alone;
Patient to bear life's burden well
    Though some be not his own.

A man whose speech is tempered well
    With kindly mingled thought,
Ready to say not what he would
    But only what he ought.

He need not come of ancient line,
    Though heritage and birth
In character and gentleness
    Is fortune rich in worth.

It matters not to know the blood
    That courses every vein
May trace its lineage back and back
    To royal Charlemagne.

Unless the heart, whose beating marks
    The flowing of that tide,
Is fuller far of kindliness
    Than of ancestral pride.

A man who more than "mother wit"
    Has Mother's tenderness;
A lion's heart for danger's hour,
    A woman's for distress.

What though his garb be coarse and rough
    His manner oft uncouth.
The purpose of his humble life
    Is kindliness and truth.

The gem is nature's handiwork,
    The setting only art;
The polish is a pleasing garb,
    The worth is in the heart."

Committee:
A. STUART BALDWIN,
ONWARD BATES,
AMBROSE V. POWELL.

January, 1921

Shaft Houses of Imposing Architecture at the Ishpeming (Michigan) Mine of the Cleveland Cliffs Iron Company

BY T. L. CONDRON, C. E., M. W. S. E.*

Criticism is frequently made that engineers do not give sufficient attention to esthetics in designing engineering structures. There are many engineering structures which serve a more or less temporary use and where it would be difficult to combine with their utilitarian purpose any features of ornamentation, but nevertheless such structures may have a beauty and dignity due to good lines expressing strength and stability. There is more beauty in the lines of the modern locomotive which is devoid of all decoration, than in the earlier locomotives which had brass plates and fanciful decorations entirely out of keeping with the use and purpose of the engine. Likewise a bridge may be so designed, without special ornamentation, that it will be an impressive and pleasing feature of the landscape. Some engineering structures and some over-ornamented architectural structures are atrocious.

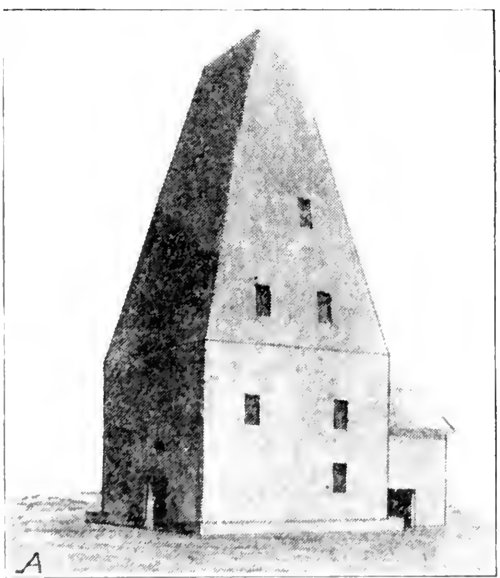


Fig. 1. Perspective drawing made from the client's preliminary sketches for shaft houses to inclose old wooden structures.

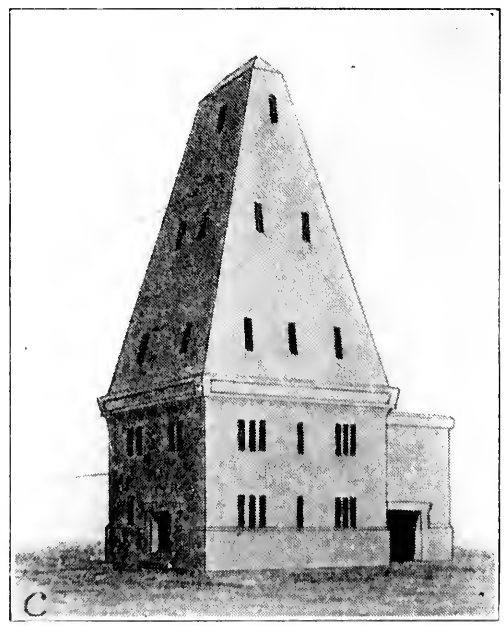


Fig. 2. Design submitted by the Engineers for the shaft houses, having the same general dimensions as the original sketches.

There has been a wonderful development and improvement in architecture and in engineering during the past score of years in this country, and engineers and architects may well work together to evolve designs of structures that will fulfill their purpose adequately and economically and at the same be pleasing to the eye. Such an opportunity was presented in the design of two of the most unusual and therefore interesting structures of reinforced concrete recently erected. These are the two mine shaft houses at Ishpeming, Michigan, of the Cleveland Cliffs Iron Company. This mine has been in continuous operation for more than thirty years, during which time many thousand tons of iron ore have been taken out without lessening the apparent deposit of ore yet to be mined. This mine has two very deep vertical shafts located 820 ft. apart, the shaft houses or head frames

*President, Condron Company, Structural and Industrial Engineers.

of which stand upon a hill within the city of Ishpeming and are very prominent features of the landscape.

The old structures were timber frames enclosed with corrugated iron and very unsightly. When hoisting loads from the mine, these frames deflected and vibrated excessively and having become decrepid with age, it was deemed necessary to replace them. The engineer and superintendent of the company, Mr. Lucien Eaton, considered three plans, namely: To replace with wooden structures of similar design; to erect structural steel frames, or to build entirely different structures of reinforced concrete.

PRELIMINARY STUDY

Studies and estimates showed that it would be unwise to build of timber, because a long life is anticipated for this mine and the fire hazard would be great. Structural steel was very costly in 1919, as well as difficult to procure. It was also felt that if steel was used, there

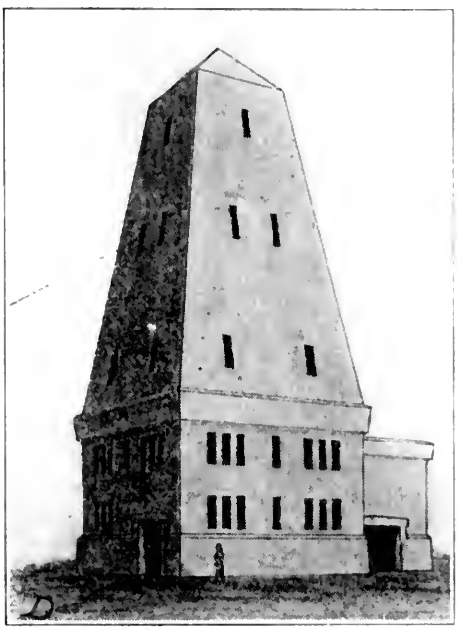


Fig. 3. Design submitted by the Engineers for the shaft houses, changing the shape of the truncated pyramid so as to make it square at the top as well as at the base.

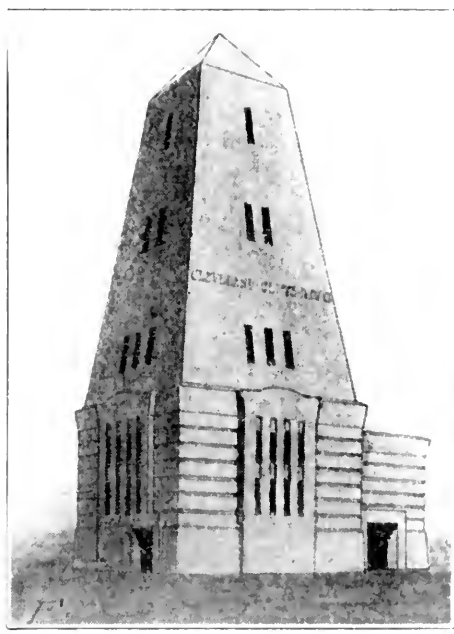


Fig. 4. The Engineers' design for the shaft houses as embellished by George W. Maher, Consulting Architect.

would be delays in deliveries and the operation of the mine would be interfered with during erection. Suitable gravel for concrete was available near at hand and unskilled labor plentiful, therefore reinforced concrete could be built with relative economy and would in no way interfere with hoisting operations. The latter feature was a most important consideration.

Sketches were made by Mr. Eaton for two reinforced concrete shaft houses, of simple boxlike construction, intended entirely to surround the timber head frames and to support timber or structural steel girders on which the main hoisting and counterweight sheaves would be carried. These sketches included plans, elevations and sections, but at the time little consideration was given to general appearances.

These sketch plans were submitted to the writer for investigation and report as to the practicability and the probable cost of the

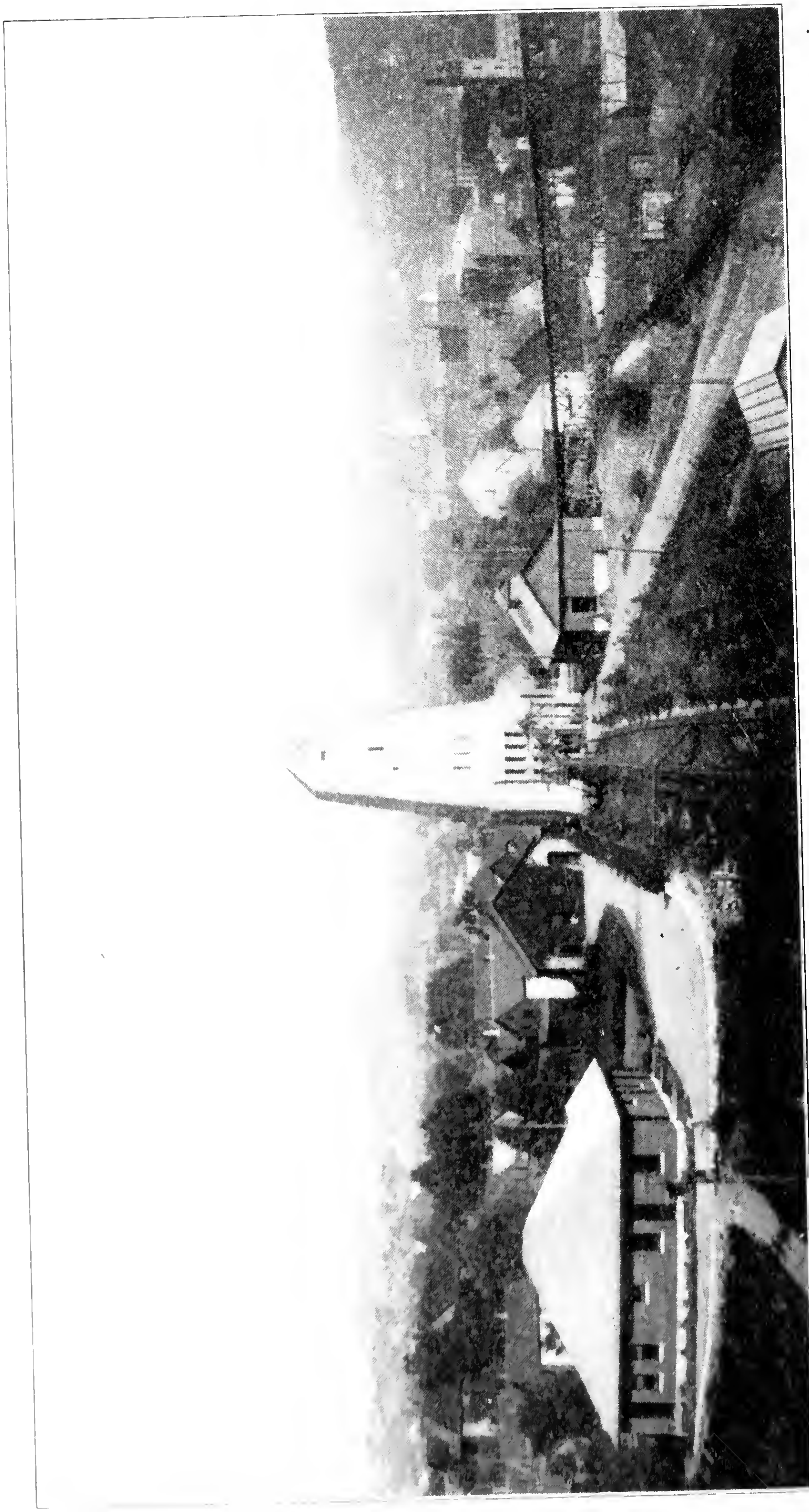


Fig. 5. Shaft House "A," viewed from Shaft House "B," eight hundred feet away. The counterweight hoisting cable leads out of an opening in the wall, near the high double windows and the main hoisting cable, through an opening about ten feet above the ground. Both cables run over a supporting framework to electric hoists in the power house between the shaft houses. The mine skip dumps the ore into a car, which is drawn by a cable up the inclined track to the crusher house.

structures, as well as to design the details of construction. The loads to be carried were great and it was evident in the timber structures that hoisting from the deep shafts was accompanied with a great deal

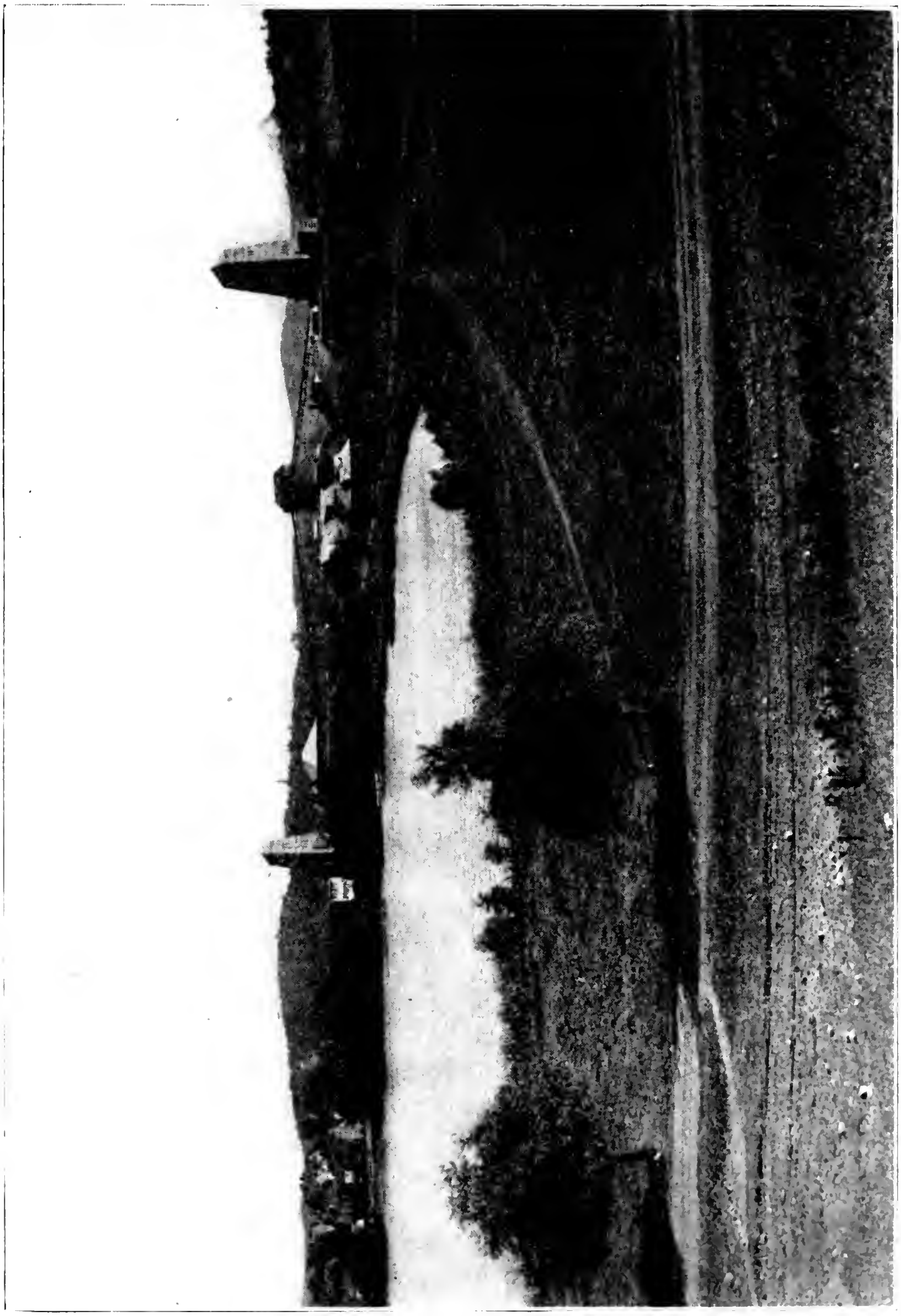


Fig. 6. Shaft Houses "A" and "B" and crusher house, as viewed from a distance.

of vibration and shock. The scheme to build of reinforced concrete was found to be entirely practical and comparatively economical, even at the prevailing high costs of labor and material.

ACCEPTED DESIGN

In order that our client might better see the possibilities and advantages of improving the appearance of these structures, we sub-

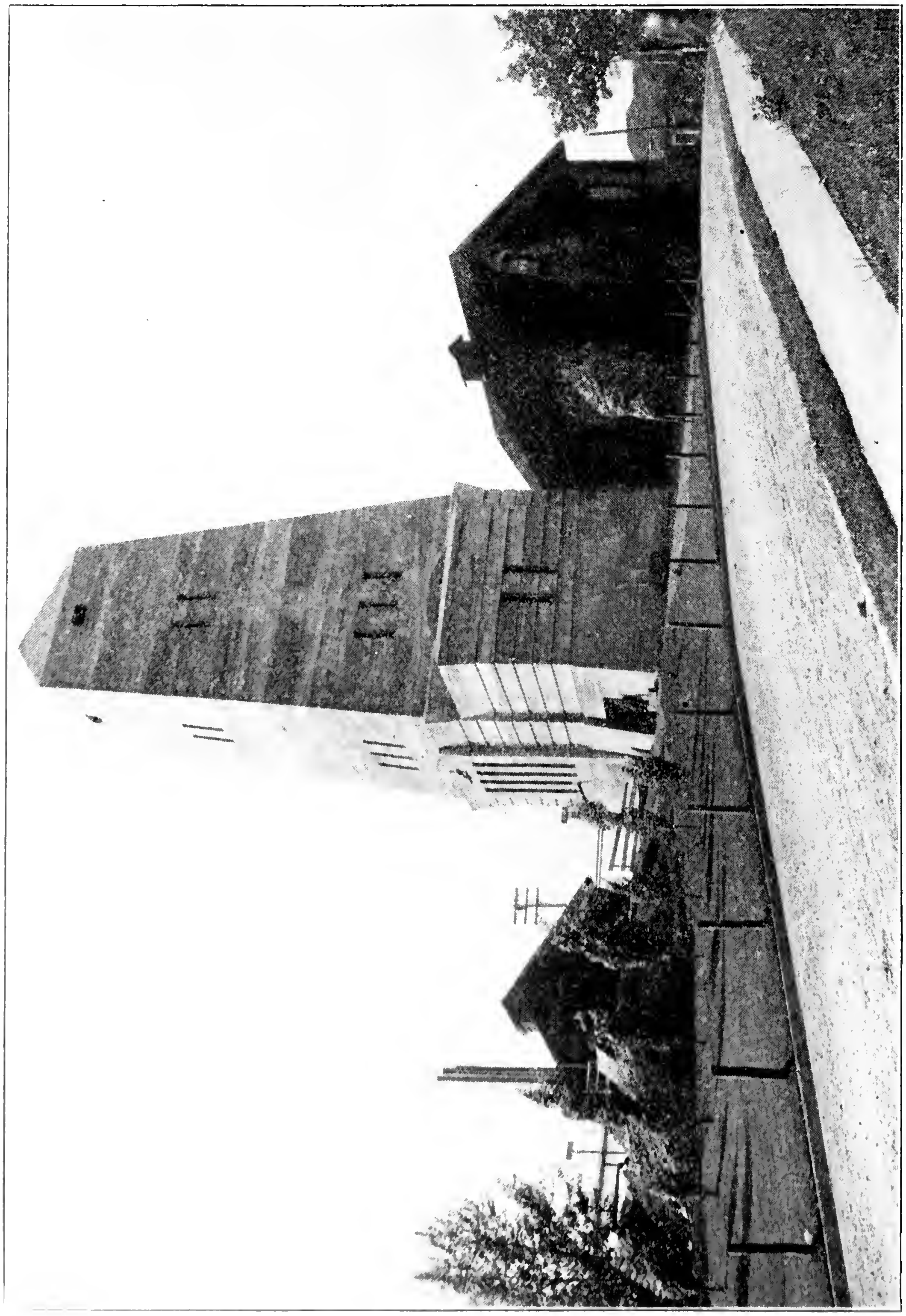


Fig. 7. Near view of Shaft House "A," with its connected car house on the front.

mitted perspective drawings made from the original sketch plans, and also from designs having simple architectural treatment but still preserving the utilitarian features. A structure like this, rising one hun-

dred feet high with a base thirty-five feet square, of necessity will be conspicuous. On our recommendation, Mr. George W. Maher was called in as consulting architect to add the truly artistic touch to the

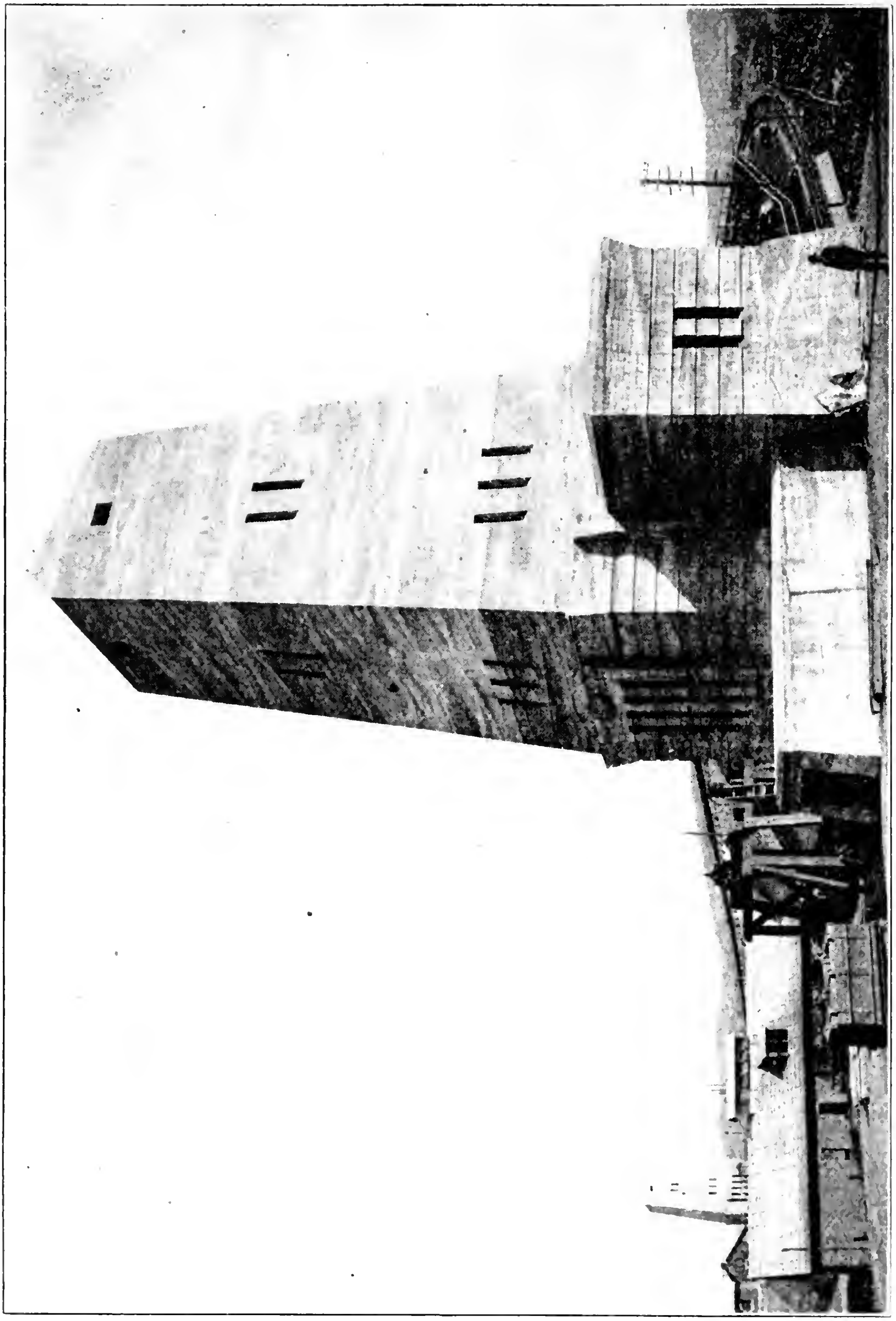
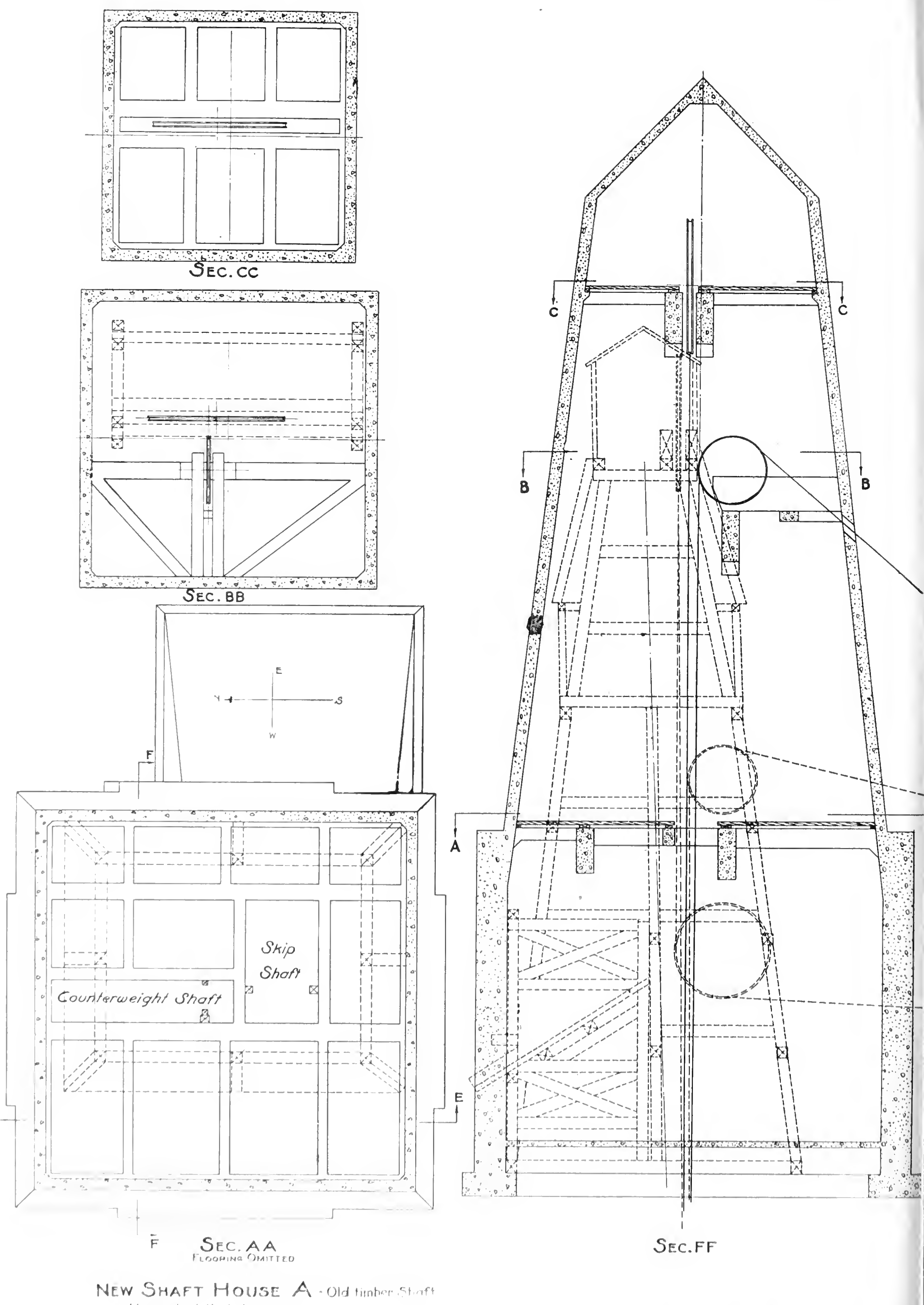
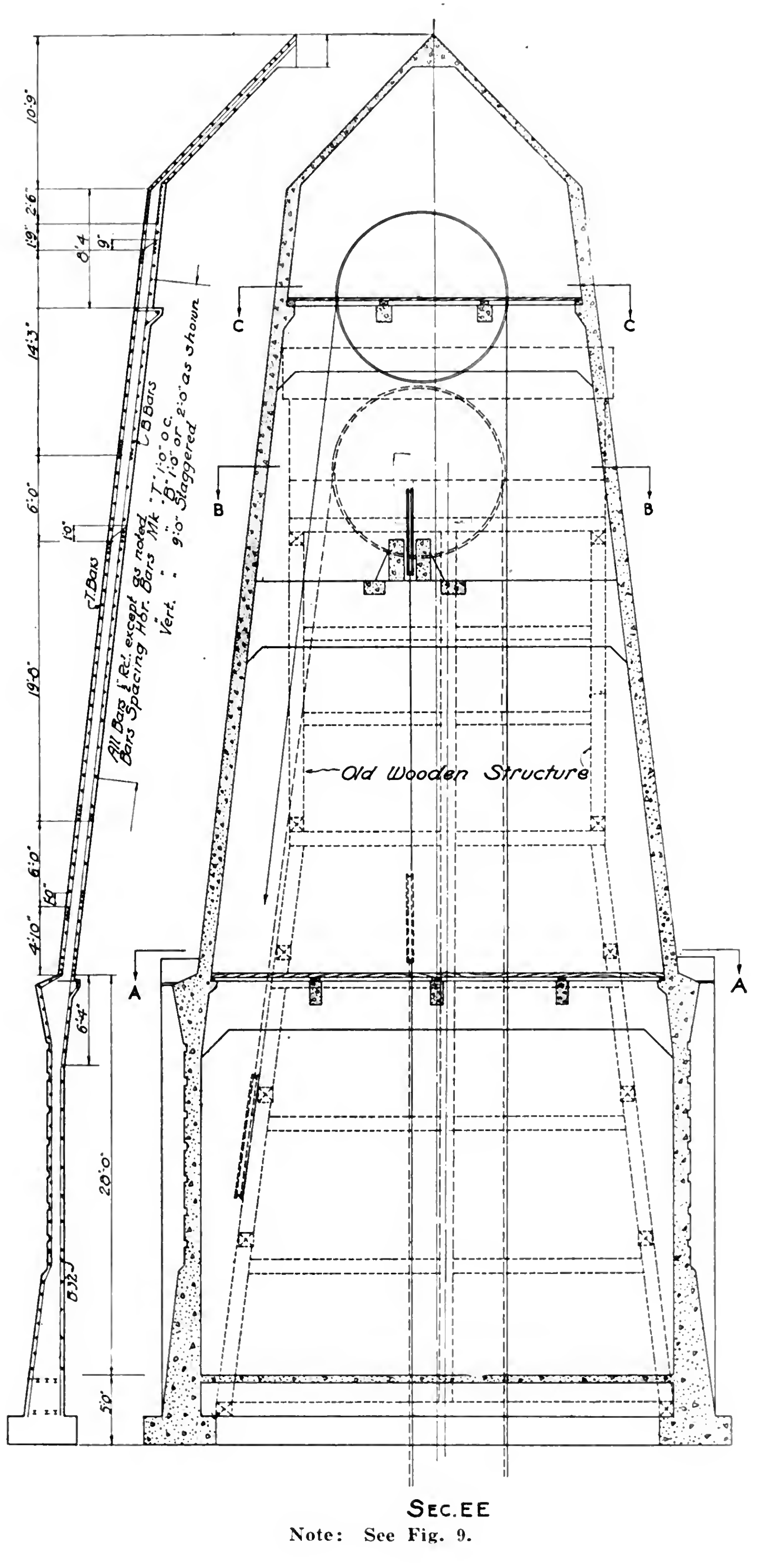


Fig. 8. Near view of Shaft House "B," with Shaft House "A" in the distance. The car house in the foreground and the inclined track to the crusher house in the background.

design. These structures were built in accordance with our design, as architecturally embellished by Mr. Maher.



Figs. 9 and 10. Vertical and horizontal sections of Shaft House "A," showing the old timber head frame and sheaves, carried by the same, in dotted lines. The sheaves, in their new positions, are shown in full lines. Care was taken to so design the shaft houses as to avoid interference with hoisting from the mine during construction. The reinforcement of the structure was designed so as to resist temperature and shrinkage stresses, as well as stresses due to dead and live loads.



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Note: See Fig. 9.

The finished structures are very imposing, especially as viewed from a sufficient distance to bring out their true proportions. The gravel used in the concrete was irregularly stained with iron oxide. Consequently, the concrete has a variagated or grained appearance of different shades of brown, pink, and grey which is very effective and pleasing and gives character to the surfaces.

The general design adopted consists of a base 35 ft. square and 28 ft. high above the ground, from which rises a square truncated pyramid 55 ft. high, 33 ft. 6 in. square at the base and 20 ft. 6 in square at the top. This, in turn is surmounted by a pyramidal cap 10 ft. 9 in. high. The total height of the structure, above ground, being 93 ft. 9 in. The walls have a minimum thickness of 12 in. except that the walls of the base are 1 ft. 1¾ in. thick with horizontal courses. The faces of the courses are each about 2 ft. separated by indentations about 6 in. wide by 1¾ in. deep. The base and the cornice of the lower portion are slightly flared from the vertical, while on each side a central feature stands out from the general face, with a plain vertical face pierced by a group of four long windows and surmounted by a flat arch. The girders carrying the main hoisting sheave are designed

Fig. 11. The structural steel head at the Negaunee mine of the Cleveland-Cliffs Iron Company. An example of a modern steel structure, devoid of architectural beauty but costing more than a reinforced concrete shaft house. A steel frame requires frequent painting, involving heavy maintenance charges that are entirely saved by using reinforced concrte.

to carry, without overstress, 75 tons, although the weight of the skip and rope is but 13 tons. The girders carrying the counterweight sheave are designed to carry 33 tons or four times the weight of the counterweight. The structures are so rigid that even at the top, no shock or vibration is felt, when hoisting is being done.

CONSTRUCTION

In a paper presented at the Lake Superior Meeting of the American Institute of Mining and Metallurgical Engineers in August, 1920, by J. Ellzey Hayden and Lucien Eaton, the construction of these two shaft houses has been fully described. The actual construction work was begun on July 21st, 1919, and both structures were completed by

December 11th, 1919. During the last three weeks of that period, very cold weather was experienced, requiring the greatest care to prevent freezing of the concrete. After cold weather set in, all materials were heated, so that in the coldest weather, concrete when deposited in. the forms had a temperature of about 80 deg. F. In order to reduce radiation over the concrete sections to be poured, extra board sheathing was nailed outside of the studding and straw packed between the form boards and this sheathing, also canvas tarpaulins were hung a few inches away from the outside face of the forms. The top surface of all newly poured concrete was well protected with burlaps. Steam pipes and radiators were also installed near the top of each shaft house. Concrete was poured on day and night shifts. After each pour, the top surface of the concrete was thoroughly roughened, all refuse blown off by compressed air, and before pouring new concrete, the surface was slushed with a cement grout.

COST LESS THAN THE USUAL STEEL FRAMES

The cost of the two structures, as given in the paper referred to, was \$47,183.00, or \$27.13 per cubic yard of concrete, exclusive of sheaves, flooring, lighting, heating, tearing down old structures, moving tracks, chutes, also supervision and engineering. The total cost of the two structures was \$56,543.00, or \$32.51 per cubic yard of concrete, with all of the above items included. The costs of some of the important items, reduced to a basis per cubic yard of concrete were: Gravel, 2.17; cement, \$3.21; forms, \$11.84; mixing and placing, \$3.20; reinforcing, \$4.79. Less than \$50.00 was expended for dressing the exposed features of the two structures. Seventeen hundred and forty cubic yards of concrete were required for the two structures and the building of the forms and placing of reinforcing was done in seventy-seven working days, while fifty-five working days were used in pouring the concrete. The foundation for one structure had to be carried down to a maximum depth of 26 ft., while the foundation for the other only had to be deep enough to avoid frost.

The engineers of the company estimated the cost of two structural steel shaft houses at \$85,000.00 exclusive of any loss of time in the operation of the mine hoists occasioned by the erection of structural steel work. On the basis of this estimate, \$28,500.00 was saved by building the reinforced concrete structures. In building these structures there was no interference with the hoisting operations of the mine, except for a period of four hours at Shaft A, one Saturday night, when it was necessary to stop the hoisting skip while pouring beams.

ADVANTAGES AND ECONOMY

A very important advantage and economy of a reinforced concrete structure is that no painting or other maintenance expense is involved. There should be a wide field for the use of reinforced concrete for mine tipples, shaft houses, crusher. houses and mills in connection with mining operations. Such buildings can be built of reinforced concrete more cheaply than of structural steel and may be so designed as to be attractive features of the landscape instead of eyesores.

The originality of Mr. Lucien Eaton, engineer and superintendent, in proposing reinforced concrete construction instead of the usual steel or timber head frames for these structures, and the broadminded policy of Mr. W. G. Mather, president, and Mr. M. M. Duncan, vice-president of the Cleveland-Cliffs Iron Company in recognizing and approving the esthetic treatment of these designs, deserves highest commendation. Instead of erecting two unsightly head frames, dominating the view in the city of Ishpeming, there now stands two monumental structures, of which the company and the city can well be proud. A further improvement may be made by conducting the hoisting and counterweight ropes through a tunnel to the power house or by installing an electric hoist in each shaft house.

TECHNICAL SECTION

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Volume XXVI FEBRUARY, 1921 Number 2

Automatic Train Control—Government Viewpoint

By W. P. Borland,*

Chief, Bureau of Safety, Interstate Commerce Commission

FOURTEEN years ago the Interstate Commerce Commission was directed by a resolution of Congress to investigate and report in regard to the use of, and necessity for block signal systems and appliances for the automatic control of railway trains. The first report in response to this resolution was submitted by the Commission to Congress under date of February 23, 1907. Block signals were at that time in use on approximately 50,000 miles of railroad lines in the United States, and in the report the block system and apparatus of different types employed in connection therewith were described in detail; also, a recommendation was made that the use of the block system should be required on the passenger lines of the country in general.

REPORT OF I. C. C. IN 1907 CONSIDERED THE NEED OF AUTOMATIC TRAIN CONTROL

That portion of the report dealing with the block system was very complete and thorough, and it has since come to be regarded as a classic in block signal literature. Concerning automatic train control systems, however, but little information was available and no conclusions or specific recommendations were made other than that further investigations, including tests, should be made. The following extract from the report clearly states the question as it then appeared:

"The question of the need of apparatus for automatic control of trains is a somewhat difficult one. Collisions occur occasionally under both the telegraph and automatic block systems, which an efficient automatic stopping apparatus might prevent. The locomotive engineman has most exacting duties. An individual runner may be far above the average in mental poise and moral character and yet may fail in vigilance or in judgment occasionally, and such failure may mean disaster. Again, the individual engineman may be efficient in a high degree, and yet the efficiency of a force of enginemen as a whole may be unsatisfactory. The engineer performs such an innumerable succession of important acts on every trip that, even with an infinitesimal percentage of failures, the forty or

*Presented at a joint meeting of the Western Society of Engineers and the Chicago Sectional Committee, Signal Division, A. R. A., Chicago. October 21, 1920.

fifty thousand engineers of the United States may still be chargeable within the course of a year with a large aggregate of fatal and non-fatal injuries. Anything less than perfection is cause, at least for investigation, if not for decided dissatisfaction.

"Every great accident due to an engineman's fault is followed by a strong public demand for the introduction of automatic train stopping devices. As previously shown in this report, such devices used to a limited extent, though not on interstate roads, seem to have given a fairly good account of themselves, but these records do not justify the Commission in making any recommendation as to their use or non-use without a more thorough and complete investigation.

"The limited extent to which devices of this character have been used makes it practically impossible for the Commission to obtain anything more than theoretical and technical knowledge concerning them. It is therefore apparent to the Commission that Congress can not be furnished with much further information concerning these appliances, which would appear extremely valuable theoretically, without extensive tests conducted by officials of the Government and at Government expense. * * *"

Acting on a recommendation contained in this report, the Commission was authorized by Congress to continue investigations regarding block signal systems and appliances for automatic control of railway trains, including experimental tests in its discretion; provision being made, however, that apparatus offered for test must be furnished free of cost to the Government.

THE BLOCK SIGNAL AND TRAIN CONTROL BOARD REPORTS OF 1911 AND 1912

The Block Signal and Train Control Board, which was appointed by the Commission in 1907 to carry out the purposes of this legislation, conducted exhaustive investigations in regard to automatic train control devices in use, as well as those available for use, and made experimental tests of six or eight automatic train control devices, which were installed for experimental purposes.

The following statements taken from the board's report of December 26, 1911, and June 29, 1912, constitute the conclusions of that board of engineers relative to the subject of automatic train control:

"The information obtained from tests, together with knowledge of the general state of development of the art of automatic train control, leads the board to conclude that there are several types of apparatus and methods of application which, if put into use by the railroads, would quickly develop to a degree of efficiency adequate to meet all reasonable demands. Such devices properly installed and maintained would add materially to safety in the operation of trains. In many situations, under conditions existing in this country, the board is convinced that the use of automatic train stops is necessary to the safe operation of trains. * * *

"Further, the board has no hesitancy in saying that had the railroads directed the same effort toward the development of automatic train-control apparatus that has been devoted to the development of interlocking and block-signalling apparatus, we should now have adequate installations of automatic train-control devices which would permit an engineman to handle his train without interference as long as he did it properly, but would intervene to stop his train if he disregarded a stop signal or ran at excessive speed where speed restriction was prescribed.

"The development of the automatic train stop has proceeded far enough to warrant the expectation that by its use greater safety can be secured in the operation of trains. Railroads should be given to understand that the automatic train stop must be developed by them as rapidly as possible."

Since the abolishment of the Block Signal and Train Control Board in 1912, the Bureau of Safety of the Interstate Commerce Commission has continued the investigation of automatic train control and other

safety devices, and has conducted additional experimental tests of devices which have been developed during recent years.

As a result of these investigations and tests covering a period of 14 years, the Commission is in possession of a considerable fund of reliable information relative to automatic train control devices. During this period much progress has been made in the development of train control systems and the application of these devices to railroad operating conditions and requirements. It has become apparent, however, that but little further advancement of the art of train control can be accomplished by experimental tests such as have heretofore been conducted under Government supervision. Most of the tests referred to have been made with a track installation of only a few miles and usually with only one locomotive equipped with the apparatus . But the accomplishment of the functions of a number of these devices under service conditions on a limited scale and for the comparatively short periods covered by official tests has led to the conclusion that the next logical step in their development is their installation and use in actual service on a more extended scale and for more extended periods of time; in other words, further development can properly be accomplished only by placing these devices in the service for which they are intended. This is necessary for the purpose first, of developing sufficiently rugged and reliable apparatus to fulfill service requirements, and second, to secure additional information regarding the application of these devices to meet varied operating conditions and requirements.

THE AUTOMATIC CONTROL COMMITTEE—U. S. R. A.

Three of the conclusions stated by the Automatic Train Control Committee of the United States Railroad Administration in its report of December 31, 1919, are pertinent:

"1. That the relative merits of the various types of automatic train control can not be determined until further tests have been made.

"2. That more extended service tests, including complete records of performance, are necessary before a decision can be reached on the availability for general practical use of any of the devices that have been brought to the attention of the committee.

"4. That on lines of heavy traffic, fully equipped with automatic block signals, the use of train control devices is desirable."

ACCIDENT—INVESTIGATIONS BY THE BUREAU OF SAFETY

As to the necessity for automatic train control devices, a study of the accident-investigation reports of the Bureau of Safety is illuminating and convincing. The following tabulation contains a summary of collisions investigated which occurred in automatic block-signal territory, caused by failure of enginemen to observe or be governed by signal indications. In some of the cases the immediate circumstances and causes were such that it is not probable the accidents would have been prevented by the use of an automatic train control system, as commonly understood, as for example, in the case of a train being operated against the current of traffic or when an engineman, having stopped for a stop signal, proceeded into an occupied block without having his train under proper control. But a study of the causes listed in this table indicates that in a large percentage of the cases noted had an automatic control system been in use, which would compel obedience to stop indications of automatic block signals, the accidents would have been prevented.

SUMMARY OF COLLISIONS INVESTIGATED BY THE INTERSTATE COMMERCE COMMISSION, WHICH OCCURRED IN AUTOMATIC BLOCK SIGNAL TERRITORY, DUE TO THE FAILURE OF ENGINEMEN TO OBSERVE OR TO BE GOVERNED BY SIGNAL INDICATIONS, COVERING THE FISCAL YEARS 1912-1920, INCLUSIVE.

Explanation of heading: C., Kind of accident, Rear collision (rc), Butting collision (bc), Crossing collision (xc) or derailment (dr).

Date	Road	Place	C.	Killed	Injured	Causes.
1911						
Sept. 4	L. S. & M. S. (Pennsylvania trains)	Dock Junction, Pa.	xc	3	36	Engine crew disregarded signals.
Oct. 19	Pere Marquette	Detroit, Mich.	bc	1	14	Contributing cause was failure of engineman to observe and obey signal protecting switch.
Nov. 2	Erie	Smithboro, N. Y.	bc	1	0	Engineman disregarded block signals and flagman's signal.
Dec. 9	C. M. & St. P.	Corliss, Wis.	bc	1	3	Contributing cause was failure of engineman to obey signal indications.
1912						
Feb. 17	Pennsylvania	Larwill, Ind.	rc	4	11	Failure properly to protect train; failure of engineman to observe and obey signal indications.
Feb. 20	B. & M.	North Adams, Mass.	rc	4	2	Either false clear signal or failure to observe signal indication.
July 4	D. L. & W.	Corning, N. Y.	rc	39	102	Failure of engineman to observe automatic block signal indication and flagman's signal; failure of flagman to use torpedoes.
July 14	C. B & Q.	Western Springs, Ill.	rc	13	29	Failure of flagman properly to protect train; failure of engineman to control speed and to obey signal indications.
Oct. 18	D. L. & W.	Hallstead, Pa.	rc	2	0	Failure of flagman properly to protect train; failure of engineman to observe and obey signal indications.
Oct. 27	L. V.	Hometts Ferry, Pa.	rc	1	1	Failure of engineman to observe and obey signal indications; failure of flagman brakeman to call engineman's attention to danger signals; failure of flagman properly to protect train.
1913						
Mar. 14	U. P.	Gothenberg, Neb.	rc	4	13	Failure of engineman to bring train under control after passing caution signal; failure to see and obey danger signal.
Mar. 14	U. P.	Herndon, Neb.	rc	5	2	Failure of engineman to observe and obey signal indications; failure of conductor and flagman properly to protect train.
July 27	L. V.	Slatington, Pa.	rc	1	31	Failure of engineman to obey signal indications.
July 30	Pennsylvania	Tyrone, Pa.	rc	1	216	Failure of engineman to observe and be governed by signal indications; failure of fireman and assistant road foreman of engines properly to observe signal indications.
Sept. 2	N. Y. N. H. & H.	North Haven, Conn.	rc	21	42	Failure of flagman properly to protect train; failure of conductor to see that train was protected; failure of both enginemen properly to control speed and to stop trains before passing danger signals; lack of adequate signal system and of proper supervision by operating officials.
Sept. 4	C. M. & St. P.	Penfield, Mont.	bc	2	11	Failure of conductor and engineman of freight train to obey train order; failure of conductor and engineman of work train to obey signal indications.
1914						
Jan. 29	Pennsylvania	Conemaugh, Pa.	rc	3	5	Failure of engineman of passenger train properly to observe and obey signal indications; failure of conductor and flagman of freight train properly to protect train.

CONTINUATION OF SUMMARY OF COLLISIONS INVESTIGATED BY THE INTERSTATE COMMERCE COMMISSION, WHICH OCCURRED IN AUTOMATIC BLOCK SIGNAL TERRITORY, DUE TO THE FAILURE OF ENGINEMEN TO OBSERVE OR BE GOVERNED BY SIGNAL INDICATIONS, COVERING THE FISCAL YEARS 1912-1920, INCLUSIVE.

Explanation of heading: C., Kind of accident, Rear collision (rc), Butting collision (bc), Crossing collision (xc) or derailment (dr).

Date	Road	Place	C.	Killed	Injured	Causes.
1915						
Jan. 1	C. B. & Q.	Liberty, Mo.	bc	......	16	Failure of conductor and engineman to keep their train clear of superior train; failure of engineman of other train to obey block signal in stop position.
May 17	S. P. L. A. & St. L.	Los Angeles, Cal.	bc	......	4	Failure of yard crew to keep locomotive clear of main line within yard limits on time of first-class train without having proper authority, and their failure to observe and be governed by automatic signal indications.
Aug. 4	N. Y., N. H. & H.	Atlantic, Mass.	xc	......	23	Failure of engineman to obey signal indications.
Nov. 24	Southern	Salisbury, N. C.	rc	2	38	Failure of flagman properly to protect train; failure of engineman to have train under control after passing signal.
Dec. 23	D. L. & W.	Slateford Junction, Pa.	rc	2	9	Failure of engineman to observe and be governed by automatic block signal indications.
1916						
Feb. 5	S. P.	Jackson, Utah	rc	1	1	Failure of crew of freight train to keep it clear of main track on time of superior train; failure of engineman of passenger train to observe and be governed by automatic block-signal indications.
Feb. 7	C. & N. W.	Dunlap, Iowa	rc	4	2	Failure of flagman properly to protect train; failure of enginemen properly to control speed of his train and obey block-signal indications.
Feb. 22	N. Y., N. H. & H.	Milford, Conn.	rc	10	152	Failure of engineman properly to observe and be governed by automatic block-signal indications.
Mar. 29	N. Y. C.	Amherst, Ohio	rc-dr	26	62	Failure of engineman either to observe or properly to interpret automatic signal indications.
July 18	St.-L.-S. F.	South Greenfield, Mo.	bc	......	31	Failure of engineman and conductor to protect by flag; failure of both enginemen to obey automatic block-signal indications.
Oct. 5	Pennsylvania	Lewistown Junction, Pa.	rc	2	6	Failure of engineman to obey automatic block-signal indications.
Oct. 23	U. P.	Bushnell, Neb.	rc-dr	2	25	Failure of flagman properly to protect train; failure of engineman to observe and be governed by automatic block-signal indications.
1917						
Jan. 17	N. P.	Marshall, Wash.	rc	3	0	Failure of engineman to observe and obey automatic block-signal indications.
Feb. 27	Pennsylvania	Mount Union, Pa.	rc	20	5	Failure of engineman to observe and obey automatic block signal indications; failure of flagman to go back a sufficient distance to protect his train.
Mar. 23	L. V.	Yale, N. Y.	rc	3	1	Either the engineman of passenger train mis-read automatic block-signal indication or the signals displayed improper indications; failure of conductor and flagman of freight train to protect its rear.
Mar. 24	N. P.	Kanaskat, Wash.	rc	......	3	Failure of engineman to observe and be governed by automatic block-signal indications.
May 26	Ft. W. & N. I.	Logansport, Ind.	bc	......	9	Failure of crew of passenger train to interpret and obey signal at junction.
Aug. 14	S. P.	Hafed, Nev.	bc	1	2	Failure of crew to clear time of superior train; failure of engineman to be governed by block-signal indication.

CONTINUATION OF SUMMARY OF COLLISIONS INVESTIGATED BY THE INTERSTATE COMMERCE COMMISSION, WHICH OCCURRED IN AUTOMATIC BLOCK SIGNAL TERRITORY, DUE TO THE FAILURE OF ENGINEMEN TO OBSERVE OR BE GOVERNED BY SIGNAL INDICATIONS, COVERING THE FISCAL YEARS 1912-1920, INCLUSIVE.

Explanation of heading: C., Kind of accident, Rear collision (rc), Butting collision (bc), Crossing collision (xc) or derailment (dr).

Date	Road	Place	C.	Killed	Injured	Causes.
Aug. 19	Pennsylvania	E. Pittsburgh, Pa.	xc	3	2	Failure of engineman and conductor to observe and obey block-signal indications.
Sept. 16	C. B. & Q.	Earlville, Ill.	rc	7	3	Failure of engineman to observe and obey signal indications; failure of flagman properly to protect rear of train; failure of conductor to have rear of train protected.
Nov. 11	P. & R.	Emaus, Pa.	rc	1	......	Failure of engineman to have speed under control after passing automatic signal in the stop position.
Nov. 11	W. M.	Garrett Station, Pa.	bc	1	5	Failure of operator to properly transfer orders to relief operator; failure of conductor and engineman to obtain permission before passing signal in stop position.
Dec. 29	B. & O.	North Vernon, Ind.	bc	8	53	Failure of crew to read and obey right-of-track order; failure of engineman to observe and obey automatic block-signal indication.
1918						
May 13	N. Y. C. & H. R.	Schodack Landing, N. Y.	dr	4	99	Failure of engineman properly to control speed of train in accordance with signal indication governing crossover movement.
June 22	M. C.	Ivanhoe, Ind.	rc	60	128	Engineman fell asleep and failed to observe and obey automatic block signal indications and stop signals of flagman.
Aug. 2	P. C. C. & St. L.	Walkers Mill, Pa.	rc	3	......	Failure of engineman to observe and obey signal indications; failure of flagman properly to protect train.
Aug. 22	Erie	West Salem, Ohio	rc	2	2	Failure of engineman to have train under control; failure to obey signal indication.
Sept. 10	B. & M.	Dummerston, Vt.	rc	3	25	Failure to wait sufficient length of time after opening switch before moving train from siding to main line; failure of crew to obey signal indications, and speed restrictions.
Sept. 17	St.-L.-S. F.	Marshfield, Mo.	bc	14	41	Failure of dispatcher to transmit train order to a telegraph operator; failure of engineman to observe and obey signal indication.
Sept. 26	D. & H.	Essex Siding, N. Y.	bc	2	3	Failure of engineman to obey signal indication.
Oct. 14	D. & H.	Schoharie Jct., N. Y.	rc	2	2	Failure of engineman to operate train under control after passing signal in caution position.
1919						
Jan. 12	N. Y. C.	South Byron, N. Y.	rc	20	130	Failure of engineman to observe and be governed by automatic block-signal indication; failure of flagman to go back sufficient distance to protect train and his failure to display lighted fusee.
Jan. 13	P. & R.	Port Washington, Pa.	rc	13	29	Failure of engineman to observe and be governed by automatic block-signal indication; failure of flagman to go back sufficient distance to protect trains and his failure to display lighted fusees.
Jan. 18	Pennsylvania	West Philadelphia, Pa.	rc	1	10	Calling-on signal, which had been displayed at caution of a previous engine, was left in caution position; failure of engineman of passenger train to reduce speed and to operate his train under proper control; failure of crew of freight train to provide adequate flag protection.

CONTINUATION OF SUMMARY OF COLLISIONS INVESTIGATED BY THE INTERSTATE COMMERCE COMMISSION, WHICH OCCURRED IN AUTOMATIC BLOCK SIGNAL TERRITORY, DUE TO THE FAILURE OF ENGINEMEN TO OBSERVE OR BE GOVERNED BY SIGNAL INDICATIONS, COVERING THE FISCAL YEARS 1912-1920, INCLUSIVE.

Explanation of heading: C., Kind of accident, Rear collision (rc), Butting collision (bc), Crossing collision (xc) or derailment (dr).

Date	Road	Place	C.	Killed	Injured	Causes.
Jan. 20	C. & N. W.	Irving Park, Ill.	rc	2	10	Failure of engineman properly to control speed during foggy weather.
Jan. 25	C. of N. J.	White House, N. J.	rc	1	......	Failure of engineman to observe and be governed by automatic block-signal indications; as well as stop signals of flagman, due to his being asleep; head brakeman also fell asleep and failed to observe signals.
July 19	L. V.	Upton, N. Y.	rc	2	2	Failure of engineman properly to observe and be governed by automatic block-signal indications; failure of flagman to go back sufficient distance properly to protect his train and to display lighted fusees.
July 31	N. Y., N. H. & H.	E. Port Chester, Conn.	rc	2	7	Failure of engineman to observe and obey automatic block-signal indications and stop signal of flagman.
Aug. 9	St. L.-S. F.	Adamsville, Ala.	bc	3	28	Failure of engineman and conductor properly to obey automatic block-signal indications.
Aug. 24	W. J. & S. S.	Elwood, N. J.	rc	1	19	Failure of engineman to observe and obey automatic block-signal indications; failure of flagman properly to protect his train.
Sept. 19	N. Y. C.	Buffalo, N. Y.	rc	......	105	Failure of flagman properly to protect train; failure of engineman to operate his train under full control after passing caution signal.
Nov. 17	Pennsylvania	Lancaster, Pa.	dr	2	1	Engineman failed to observe and be governed by automatic block-signal indications.
Dec. 18	N. & W.	Walton, Va.	rc	5	12	Failure of engineman to operate his train under proper control after receiving a permissive indication of calling-on signal; failure of flagman properly to protect train.
1920						
Feb. 15	A. G. S.	Trussville, Ala.	bc	5	1	Failure of engineman to obey meet order and to observe and obey signal indications; failure of conductor to take prompt measures to stop train.
Feb. 26	C. St. P. M. & O.	Eau Claire, Wis.	rc	......	14	Failure of engineman to operate train under proper control as required by signal indiactions; failure of flagman properly to protect train.
Mar. 3	C. of N. J.	Elizabethport, N. J.	xc	1	17	Failure of engineman of main-line train to observe and obey signal indications.
Mar. 14	S. M.	Leeper's, Ind.	rc	1	10	Failure of motorman properly to obey signal indications.
May 3	O. W. R. & N. L.	Huron, Oregon.	bc	1	15	Failure of engineman to read timetable correctly and his failure correctly to observe and be governed by signal indications.
June 9	N. Y. C.	Schenectady, N. Y.	rc	15	43	Failure of engineman properly to observe and be governed by signal indications and stop signals of flagman.
June 14	D. & H.	Gansevoort, N. Y.	rc	......	54	Failure of engineman properly to control train in occupied block; failure of flagman properly to protect train.
June 15	B. & A.	Worcester, Mass.	rc	2	1	Failure of engineman properly to observe and be governed by signal indications and stop signals of flagman.

THE TRANSPORTATION ACT

The Transportation Act, 1920, materially increases the powers of the Commission with respect to automatic train control and other safety devices. Section 26 of the amended Act provides in part as follows:

"That the Commission may, after investigation, order any common carrier by railroad subject to this Act, within a time specified in the order, to install automatic train-stop or train-control devices or other safety devices, which comply with specifications and requirements prescribed by the Commission, upon the whole or any part of its railroad, such order to be issued and published at least two years before the date specified for its fulfillment. * * *"

The administration of this section of the law is now before the Commission for consideration, and plans for carrying out its purposes are being formulated. It is the purpose of the Commission shortly to inaugurate the work of further developing available train control devices, looking to their practical use by railroads in locations which may be decided upon by competent authority, and to this end it has invited the co-operation of the American Railroad Association. It has been suggested that a representative committee be appointed to co-operate with the Bureau of Safety for the purpose of working out the details of a practicable plan for effectuating the purpose of Section 26 of the Interstate Commerce Act.

The enactment of this legislation marks an epoch, from the Government viewpoint, in the development of the art of automatic train control. The period of experimentation has passed; the necessity for automatic train control has been established and the question as to the practicability of automatic train control has been answered in the affirmative. The primary purpose of the former legislation, namely, to determine whether the automatic control of trains is feasible, has been accomplished, and opportunity has been afforded the proprietors of such devices to secure unbiased reports, to develop them along proper lines, and in some cases to conduct experiments and to demonstrate the merits of their devices. The termination of this period of experimentation ushers in a period of practical development. The present automatic train control problem is not one of invention, but rather one of engineering; the product of the inventor is to be taken over by the engineer and developed and applied for the useful service for which it is intended.

Under the former legislation the apparatus provided for installation and test was required to be furnished in completed shape, free of cost to the Government. While under the terms of the law the Commission was allowed to exercise its discretion in respect to experimental tests to be conducted, it was considered, in view of the undeveloped state of the art and the diversity of opinion as to the proper functions of an automatic train control system, that it would not be policy to attempt to prescribe detail specifications and requirements for apparatus presented for test; and it was obviously out of the question for the Government engineers to act in a purely consulting capacity or offer constructive suggestions relative to details of apparatus presented for test. The criterion observed was that the device presented for test must be fundamentally correct in principle of design, the device must be of such character that development in the art of automatic train control might reasonably be expected from the ex-

perimental test, and workable apparatus must be provided; and tests and reports were made upon that basis. It was probably inevitable under this plan that some of the apparatus offered for test was far too delicate for the service intended, and in some cases extremely crude as compared with present day signalling and interlocking appliances; furthermore, in some cases there was considerable question as to the desirability of certain functions accomplished by devices tested.

The recently enacted legislation places an entirely different aspect upon the matter. This provision of the law contemplates that the locations where installations are to be made shall be designated and that specifications and requirements to which the devices to be installed in these designated locations must conform, shall be prescribed by the Commission. There has been more or less criticism of the "requisites" and "desirable characteristics" for automatic train control systems which have been promulgated from time to time by different bodies, the burden of complaint being, on the one hand, that requisites covering all systems and operating conditions resulted in excessively severe requirements, and, on the other hand, that desirable functions and features were not specified in sufficient detail.

The terms of the provision of the present law, however, apparently preclude such difficulties. Specifications and requirements prescribed for a device which is to be installed in a designated location no doubt will cover the functions to be accomplished by the apparatus as well as the characteristics of the apparatus itself.

The installation and use of an automatic train control device by a railroad company offers far greater promise of successful application and operation than does the installation of a device of this character by the inventor or proprietor made for the purpose of an experimental test. The inventors or proprietors of these devices frequently are not signal men or competent engineers, and in many cases they have no proper conception of railroad operating conditions and requirements; the financial resources of many of them have been extremely limited. Notwithstanding these facts, such men have been given practically a free hand in making experimental installations, the principal and some cases the only apparent concern of the railroad company being that the proper operation of trains should not be interfered with. But in the installation of an automatic train control device by a railroad company all the talent of the engineering, construction and maintenance forces is available; and while it is true that experience with train control devices is limited, much of the experience obtained from the construction, installation and maintenance of signalling and interlocking can readily be applied to the problems presented by an automatic train control installation.

The administration of Section 26 of the Interstate Commerce Act will inevitably result in great strides in the development of the art of automatic train control and I confidently anticipate that, as suggested by the Block-Signal and Train Control Board in 1911, we shall shortly have in service adequate installations of automatic train control devices which will permit an engineman to handle his train without interference as long as he does so properly, but will intervene to stop his train if he disregards the stop indication of an automatic block signal or runs at excessive speed where speed restriction is prescribed.

Problems in Installation of Automatic Train Control

By W. B. Murray,*

Chief Engineer, Miller Train Control Corporation

IN the discussion of some of the problems which must be considered by the railroads in the installation and use of automatic train control appliances, it is convenient to have this paper confined to demonstrated facts, rather than to a theoretical "desirable requisite" program. Each particular factor in train operation has its own definite function, and all are considered from a practical view-point. The automatic train control, like other appliances, performs only the particular functions intended; for after all, its scope is limited to specific performances. It is therefore, entirely in keeping with all other practices of railroading to consider the automatic train control in its relation to the work to be accomplished.

The question of desirability of the automatic train control has been answered in the affirmative by many witnesses and by some unmistakable facts. In view of the tests and records of years of actual service, it is inconceivable that any railroad officer responsible for the safe operation of trains would hesitate to favor the use of the automatic train control, provided, of course, that such devices meet his operating requirements and at a cost commensurate with results.

There may be, and is, a wide divergence of opinion as to just how train control should be installed and what it should do, this divergence of opinion ranging all the way from the simple practical method of stopping trains for danger signals, and thus preventing certain classes of accidents, to the super-refinements which would, in theory, if not in fact, produce not only an ideal automatic train control, but an automatic engineer as well!

It has been demonstrated beyond a doubt that the display of signals or signs along the right of way or in the cab does not stop the train (in case of danger) should the engineman for any reason fail properly to interpret the signals and apply the brakes. Therefore, it is a well recognized fact today that the only way of reducing to a minimum the dangers of collisions and certain classes of derailments is through the employment of mechanical means to enforce obedience to signal indications and track conditions.

THE FUNCTIONS OF AUTOMATIC TRAIN CONTROL

Now, may not this question be asked with all propriety: What fundamental functions should the automatic train control perform? (This question is easy enough to answer in that the same principle is involved as when an engineman acts on seeing a signal at stop.) To enforce obedience to stop signals by applying a service application of the brakes should the engineman fail to act for any reason.

*Presented at a joint meeting of the Western Society of Engineers and the Chicago Sectional Committee, Signal Division, A. R. A., Chicago, October 21, 1920.

All will concur in this statement, that, given a positive impulse in cab negatively controlled, almost any action may be performed on the engine, such as the displaying of signals, making of records, blowing whistles, ringing bells, etc. Many different types or systems have been employed to get this impulse, and that the same time comply with clearance requirements, and a grand rush by many theorists and would-be inventors to the Patent Office has occurred, resulting in thousands of patents having been granted, most of them being unworkable in practice.

Those who have worked any considerable length of time in this art have achieved largely through a process of elimination and are students in the school of hard knocks. They have realized long ago the truth of the old saying that a "swallow does not make a summer" and that a patent does not make a train control, and they have also profited by the axiom "Where practice disproves theory, change the theory."

SOME OF THE DEVICES IN SERVICE

The principal devices which have been tested on railroads and which are in use today are the trip type, such as the Kinsman system in the subway of New York; the induction type, in service on the Western Pacific in California; the intermittent electrical contact or ramp type in service on 19 miles of single track on the C. & O., 25 miles of double track on the Rock Island, and on 107 miles of double track on the Chicago & Eastern Illinois. The general results of the experiences with the above mentioned devices have been more or less successful and have warranted further trials and use, until today there are automatic train controls in actual service, handling all classes of trains and handling them satisfactorily, according to the testimony of officers and trainmen who are using them.

The ramp type has been in actual service on different roads long enough to answer the clearance question (at least on roads using it), to satisfy the officers as to the permanency and dependability of the different forms of construction and to answer fairly correctly the question as to cost and installation and maintenance.

THE PROBLEMS OF REFINEMENT

Among the problems confronting the railroads in the installation of automatic train control is the one regarding the extent to which they desire to go in the first stages; that is to say, what functions may be desirable over and above the control or stopping of the train for stop signals? The development of the airbrake and the visual signal certainly furnish the only logical example to be followed in the evolution or refinement of the automatic train control. Surely these two very important factors in train operation did not start out as at "finished product." It was only through long usage and steady development and improvement, a little at a time, that the air brake and the visual signal attained their high state of efficiency and became practically indispensable. The automatic train control development has been along similar lines and now claims the same consideration from all thoughtful railroad officers.

It seems to be the concensus of opinion—and the point is undoubtedly well taken—that if the engineman was always normal, at his post

of duty and functioning properly, there would be no need of a train control. But it has been demonstrated on many occasions that the engineman errs, not only as to the correct interpretation of the signals, but also in judgment as to the distance he may be from the signal and the speed at which he is running.

The automatic train control not only stops the train when there is danger ahead, but by the same installation and the laws governing it, indicates the clear signals, thereby warning the engineman that they are approaching a signal, that the signal is clear and that it is safe to proceed. To this extent the automatic train control facilitates traffic, as well as providing added protection against collisions and certain classes of derailments.

On one railroad a service application of the brakes is made when a caution signal indication is displayed and approaches a signal displaying a "stop" indication under control; on another railroad the officers decided that the first essential in operation was to insure a *stop* for a stop signal indication, so ramps were placed within braking distance of the signal, allowing the engineman to handle his brakes as his experience and judgment directed. In the main this has resulted in general satisfaction; the high speed passenger trains making a satisfactory and smooth signal stop; the enginemen on freight trains lap the valve as soon as the desired reduction is obtained.

If it is necessary for the engineman to make a station or water plug stop between a ramp and a stop signal, he will bring his train under control, and by a willful act let himself over the ramp. Under this form of operation the engineman has absolute control. But it should be specifically noted that he must perform a wilful, deliberate act at the time he is passing a control point or ramp, otherwise he will receive a brake application. *He does not cut out the control—he clears himself.*

In a paper read before the New York Railroad Club on March 19, 1920, Major Ames said:

> "If we consider the sequence of events that must take place between the obstruction of a track on a railroad and the stopping of a train because of this obstruction, we shall find that these events occur substantially as follows:
>
> 1. A metallic path is established between opposite rails of the track circuit.
> 2. A sufficient portion of the track current flows through this shunt to reduce this amount of current through the coils of the track relay below the minimum required to hold its armature attracted.
> 3. The control circuits of the signals open at the contacts of the de-energized track relay.
> 4. The line control circuits are de-energized.
> 5. The slot or hold-clear magnets of the signal become de-energized.
> 6. The mechanical latch or other hold-clear mechanism of the signal releases.
> 7. The signal arm, under the action of the gravity, assumes the stop position displaying the stop signal indication.

8. The engineman sees the signal.
9. The engineman senses and interprets its indication.
10. He decides to stop his train.
11. He shuts off his power.
12. He manipulates the air-brake valve handle.
13. An outlet for air-brake pressure to atmosphere is established.
14. The train line air pressure falls.
15. The triple valve operates.
16. Reservoir air is admitted to the brake cylinders.
17. The brake piston, rigging and beams, operate to cause application of the brake shoes to the wheels.
18. The energy of motion of the train is converted into heat and the train retarded and finally stopped."

Of the above 18 operations all but 5 are automatically performed by mechanical devices without human intervention. Numbers 8 to 12 inclusive are performed by man. The automatic train control is the connecting link between the track, signals and air brake.

Considering further Mr. Ames' "sequence of events," we find that all the "events" up to No. 12 are employed to induce the engineman to apply the brakes, and the remaining 6 are but natural mechanical events which follow the manipulation of the air-brake valve handle. Mr. Ames well says:

> "It seems remarkable to many persons familiar with the great extent to which other sequential operations in industry are made continuously and completely automatic that the integrity of the sequence of operations required to stop the train, especially in view of the importance they may at times assume, has continued so long to remain subject in such a degree to the chances of human fallibility."

WHAT THE INSTALLATION OF AUTOMATIC TRAIN CONTROL HAS ACCOMPLISHED

It has been demonstrated beyond controversy that the automatic train control *enforces* the application of the brakes, eliminating all danger from the possible failure of the human element.

On different occasions articles have been written and statements made that "The use of an automatic train control would have a tendency to make the engineman careless, but observation based on a careful watch and check extending over a period of several years' service operation on a railroad using an automatic train control shows that the contrary is true. The use of the automatic train control has a tendency to keep an engineman wide awake and on the job. This is a demonstrated fact and experienced men in the service bear testimony thereto. It is possible that there are men present from different railroads who have had experience with the automatic train control that can give more light on this particular point. But it is the purpose of this paper to endeavor to bring up some of these questions, answer them as yes or no and submit the evidence for the fact.

Statements also have been made that the use of an automatic train control would retard traffic. The answer to these statements is that its use facilitates traffic under certain conditions, and it will enable the railroads to run more trains with added protection.

Some control enthusiasts have taken the stand that the automatic train control would take the place of the signal. This idea is erroneous and the facts all go to prove that the automatic train control is an adjunct to the roadside or visual signal, and its primary function is to enforce obedience to fixed signal indications. In its simplest form of application it does not take away anything from the engineman, therefore, it does not lessen his responsibility and it has been observed that by its application it has a tendency to eliminate the overrunning of signals because of the fact that the engineman is warned that he is approaching a signal location and apprised of the situation, should he be employed on other duties in the cab at the moment.

It has also been observed in years of experience that very frequently in a trip over the road an engineman will receive a caution signal indication and find his next signal at stop, when just about the time that he applies his brakes and the train is retarding, the signal will assume the proceed position. All will agree that it is good railroading for the engineman to release his brakes and proceed according to the visual indication.

Certain amplifications or accessories easily may be added to the elementary stopping device that bring in no complications and do not lessen the responsibility of the engineman, but their status must continue to be of an accessory nature and their desirability depends on individual requirements.

THE CLEARANCE PROBLEM

All who are familiar with the automatic train control know that an air gap of several inches exists between the locomotive and the roadbed at a line even with the top of the running rail. This gap must be bridged and thus we are confronted with one of the greatest problems, namely, clearance. The roadside or track member must not interfere with the rolling stock, or vice versa.

Referring again to the matter of clearances: In the development of any new art along the mechanical or electrical line, certain fixed conditions or limitations have to be considered. Yet successful engineers, like men of other professions, are inevitably following the path of least resistance. After deciding on the type of roadside member to be used, it is necessary to determine the distance that it is to be placed *out* and *in*, *up* and *down*. Certainly there is no good reason to say that the present position of roadside members is final, or that the distance out and up from the running rail is arbitrarily established. But standardization of clearances for the automatic train control will be established when the occasion demands it.

THE MAINTENANCE PROBLEM

The maintenance of the simpler forms of automatic train controls is very low compared to the benefits derived and as compared with other devices that are in use on locomotives. It has been found that the regular engine inspectors can take care of the device the same as the other parts of the locomotive, and that repairs and maintenance are made by the regular maintainers in the different shops and round houses. In other words, it does not require a large force of specially trained or technical men to install and maintain engine equipment.

The roadside or track members of the successfully demonstrated devices in use on steam service railroads today are stationary. That is, they are attached to the ties adjacent or between the running rail. Years of constant service have shown that there is very little, if any, appreciable wear on the ramps. The maintenance of the ramps is taken care of by regular trackmen, and the electrical connections are looked after by the regular signal maintainers.

OPERATING RULES PROBLEM

So far as is known, there has been no change in the book of rules brought about because of the operation of the automatic train control and an engineman is not relieved of any responsibility nor is the discipline lessened.

In conclusion, it should be emphasized that the results of the operation of the automatic train control have conclusively proved that:

(1) It enforces obedience to signal indications and track conditions and automatically stops the train for a stop signal if the engineman fails to act.

(2) In fogs and storms it helps the engineman in the better handling of his train by giving him a clearance indication (if the signal is clear) at braking distance from the signal, and to this extent actually facilitating traffic.

(3) It performs its functions properly under all weather conditions which will permit running of trains.

A Railroad Operating View of Automatic Train Control

W. G. Bierd*

Reviewing hastily the progress of train control as we have it today, it has been a steady but very slow process, until very recently, when the best automatic train control has rapidly come into existence because the operating man and those responsible for the railroad systems found the great value of the present train control devices, which as we see them today, or refer to them, are largely the automatic signals.

But we are hardly fair in that respect with the other devices of train control. Only a short time back in the railroad progress we had the very simplest means, the well-known, but very simple signals displayed by direction of the train dispatcher through the operator.

Finally we worked out the block signal system in a very crude form. That had only begun to be effective when the greatest and most perfect train control device of all was handed to us, the automatic air brake, as we now know it, which was rather crude in the beginning. It was not automatic in the beginning. It was what we then knew of as the old straight air.

The braking capacity was carried upon the engine, and the use of that braking capacity was entirely dependent upon the use of the engineer's application, the train, whether freight or passenger, long or short, whether many or few units, was free, and the trains often

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parted. Bad results, collisions, breaking of equipment all followed when the automatic air was given to us. But it has been thought out and perfected to the very high degree, as we now find it, so that when properly used, when the proper human agency is applied, we have an absolutely perfect train control, assuming, of course, that the mechanism is working as it was constructed to work, mechanically correct.

That has been so perfected that there is very little opportunity of failure there. But it is the operating man's experience by all of these years of operation, and with all of these devices—first, the crudest signalling, as crude as the first air brake, which you gentlemen have so ably perfected, and today we have the automatic signal, so that we have a perfect automatic train control, providing, however, that the human agency operates as perfectly as the apparatus.

There is our failure. There is the thing, and the only thing that is now to be overcome. We would not need anything more than the present automatic train control furnishes us if it were not for the failure of the man, the failure of the human agency. Therefore, by passing along that progress of about 42 years, we come to the point where we can no longer say—automatic train control. We have to consider automatic train stopping. That is what we are seeking for, and that function must be automatic, because through every agency of mechanism so far the failure occurs whenever the human agency fails to do the thing that you men have to put into that human agency's hand to operate.

We have the failure of the flagman. His duties are simple and very plain. We can discipline, we can educate, and we can school, and make a very perfect flagman, but we have never been able, and we must assume that we are never going to be able to control the weaknesses of that human agency. It is really remarkable what does occur in the failure of men in performing their duties.

I have been investigating such cases for a good many years, and I have been on the side to be investigated. I have made those errors myself, and I have found every other employee of a railroad subject to those errors. They are the human errors that we cannot locate.

I find that in the train service and engine service there are three outstanding principal reasons for men's failures.

For a long time we attributed it to the question of intoxication or the drinking of liquor, men going out on the road in some degree of intoxication as the greatest evil that we had to contend with.

It has been my experience, and since that is practically a thing of the past—and I do not refer to the recent prohibition acts—our railroad employees have practically become total abstainers or, at least, a perfectly sober body of men some time back, so that the element of intoxication among our men has not been seriously prevalent for some little time.

Yet those other reasons exist.

I find first, at least I am satisfied in my own judgment, that the largest number of failures of men in train service are due to various domestic troubles: illness in the family, illness of the man himself, and any other thing that directly affects the harmony and peacefulness of the home, puts the man in a frame of mind that he is not responsible. He broods and studies over that thing that is troubling him

more than any other one thing, when the family or home is a subject of concern to him. No matter how simple, no matter how thorough your rules may be, no matter what your cautions have been recently, that man or men have left the classroom, strict in every respect have been their duties, and upon their rules, and yet the striking thing is in the way in which we wonder how the man forgot his obligation.

But he does, and the mind ceases for that fatal moment to serve that man until the accident occurs. The man's moral standing is good. The man's integrity to his duties is perfect. The man's knowledge and education is perfect, and he knows every one of the things that he is doing, but because of that temporary derangement or absence of the mind, he makes this mistake, and I have never yet found even an approach to the cure or remedy of that. So that I feel that the unsafeness of the human agency is with us in the operation of our trains, just so long as we rely upon that human agency.

A man's personal health is a very serious thing in the carrying out of his duties. A man ill is not fit to perform the duties of a locomotive engineer or a conductor whose responsibility for the safety of that train is so great.

There is another and important thing that I believe there is no means of overcoming.

Then comes his financial obligations, any things that weight down, burden and stump the mind to that degree that temporarily the mind is not a responsible one; so long as those things exist and you overtake and control men's minds—and I think that is as long as we employ men and trust to their agency—we must expect these failures to occur. That has been emphasized more distinctly since our present method of signalling has been in effect than when we were dependent upon the train or with the ordinary meeting point, the wait or the passing order. We have found these surprising conditions that men have set in their cabs. Surely they knew what the automatic signal was for, they knew that signal meant caution or a positive stop, and yet I have been surprised in my practical experience—at first hardly able to believe—that a man would sit in his cab and directly and positively see that signal before him, knowing all of its meaning, and yet fail to observe it or obey its purpose, and the accident occurs.

Then we always have, of course, the question of a possible failure that it is never possible to clear or satisfy ourselves about.

So that, if those things are true, and my experience has proven to me they are true beyond a question, then we must look for a truly automatic train control or train stop.

As the last speaker said, an automatic man—that is what you are seeking. That is what you signal engineers have got to study and produce, if it is possible to do so.

And until then, or until something far better than we have—and our automatic signal control of trains is about as near perfect as we could hope for, but they fail to that extent that they cannot step in and perform the functions when the human man fails. Therefore, we must look for and have that device, that mechanism that will take the place of the man when he fails.

So far that is entirely a forward movement. I know of nothing in the opposite direction. We will therefore, have to rely upon the

human agency for a time until those desired automatic devices are produced.

I refer to running the opposite tracks, and such things as do occur, detouring, etc. So far as I know, that is less advanced than the opposite.

Now then, what should we undertake to do? Should you gentlemen be expected to deal with and study the entire question as a whole, or should we first consider terminal protection. Out in the country, on our straightaway lines of road, true that there the speed is the highest, the speed the greater, and to that extent the hazard perhaps the greater, but not so in reality, not so in practice. True that we have accidents upon that class of track and with that class of train, but in the congested centers, the congested terminals, where many movements are being operated and made at one and the same time. Shall we devote our efforts to terminal protection, first, of that nature?

My thought is that that is the first essential for the reason that as far as I am familiar, and that is very limited, with any of the present mechanisms, high speed is not yet thoroughly overcome where the moving train and your automatic control device come in contact. I think that as far as I know is the weakest point of any one of the present systems. Therefore we could well protect and work out our congested terminals, because, as a result of present-day operation, the speed of your trains and the approach of the trains is quite different than that of our high speed tracks.

Next, of course, it would be desirable that we consider our important crossings. There is the only positive automatic stop that we now know, which is the derail, but attended always with disaster when that human agency fails, so we have the great importance of protecting and the laws have undertaken, the laws of every state in the union have undertaken to protect railroads crossings first, before we had an effort to protect each other in any other manner. So the railroad crossing is of great importance, and we must find something better than the present method of forcible stopping when the human agency again fails us.

I believe, gentlemen, that it is no longer necessary for us to talk about the necessity of a better train control device. It has been greatly improved, and we have a splendid system today, but again it is only a matter of reading the notes you have before you. I doubt if any of us realize in our own busy life and in our own small sphere, the loss of life and limb and personal injuries and death that is occurring in this country in the operation of our trains, still entirely too high to even think that it should be permitted to go on, when something better can be had. It runs into hundreds yearly. It does not seem possible that a word is necessary from me to impress upon any one the necessity of a better device, if such a better device is known. Therefore, I think it is as plain to each of you in your professional life as it is to me from an operating standpoint, that such a device is absolutely necessary.

I listened here, and of course, was familiar during the effort on the part of congress and the Interstate Commerce Commission, and finally the greatest of all efforts that has been put forth by the government in the enactment of the present law of 1920. Congress has been interested in this subject for a long time, but not as interested

as they should have been. It was a passing interest. They have offered some slight inducement. The next step, when they had the agency of the Interstate Commerce Commission, was to make certain investigations. The Interstate Commerce Commission have called upon you and other technical men. They have made such investigations and reported back to Congress.

It hardly seems reasonable, gentlemen, that such a process should have been permitted over the period of time that it has been. But I presume that is not different than many other of the same important things. Congress is a very large and almost unwieldy body of men, viewing things from their different angles, slow to act, as a central government is always slow to act in such public things, while as public agents entrusted to protect the government, they are too prone to allow the individual, the corporation or the man himself to work out the device. So that there has been no inducement and this multitude of patentees that we hear about here tonight, they have not realized and know this as they know and realized the necessity of the automatic signal in its earliest stages. Individuals were allowed to work out and perfect what we have of the signal. The government gave little help and assistance to bring about such splendid devices. The same was true with the air brake, and so on through.

A few years ago the government practically ordered every railroad in the United States, indeed it was a direct order, that we should produce and operate on our railroads an automatic mail changing device. Many men spent comfortable and even independent fortunes in trying to produce that, and after years of study of a very worthy thing, by the wishes and by the call and almost by the directions of our general government, when they had become a reality, when four of such devices were even further advanced and more nearly perfected than your present automatic train stops are today, that same government practically repudiated that entire effort, and those men's moneys and years of work were gone.

Today the government says such a device is not especially necessary.

So the government has sat back upon this important thing, and we have heard stated here tonight, by this gentleman who is so thoroughly informed upon this subject, that if the railroads would have expended the amount of money on developing the automatic train stop or control that they have upon signalling and interlocking plants, it would be a developed reality today.

I just want to reverse that question, and say that if the United States government had expended as much money to directly have employed you to develop a train control device that they have expended upon their agents travelling all through the country to try to find out the details of what caused the accident, and injured or killed some people, we, too, would have had developed and perfected a train control device today. The railroads are practically in the hands of the Interstate Commerce Commission. Congress has taken a definite and direct step in the right direction, and they have said to the Interstate Commerce Commission that "you are now empowered to say to and compel the railroads to develop and operate, as early as possible, these

improved automatic train control or train stops." That is going to do a great deal of good, but still I am not just in accord with that. It is not good enough. It is not going far enough.

I am just tying to the old New England adage that "what is everybody's business becomes nobody's business."

I have no doubt but what these men here, these expert signal men are going to continue their efforts, but so far as there are only a few that have given devoted time to that, only a minor advance step has been taken.

I believe that your Society, and now that the American Railroad Association is in part recognized as an agency of the Interstate Commerce Commission, Congress should be directly appealed to, through the Interstate Commerce Commission, and I think that your report should tend in that direction, to say that we want a definite and ample appropriation of money that we can employ the best talent there is, divorce them from their many duties at home, and put them upon this subject, let them develop it, and perfect it, and you will not wait for the long process of the development of the signal, the development of the air brake, and the development of all of the other safety appliances that we have on railroads today.

Therefore, it is my conclusion, gentlemen, that our general government will not have performed their full duty until they have made a proper appropriation, placed that in the hands of the Interstate Commerce Commission, with direction that it shall be used to perfect this much needed device.

Letter Discussion of Mr. Borland's Paper on Automatic Train Control

By Frank J. Sprague*
New York

I regret that I am unable, on account of a previous engagement, to take personal part in so important a discussion of the next great improvement in railroad operation, the prospects of which have recently been so materially brightened.

I would, however, take the occasion to congratulate those fortunate enough to be present, on the opportunity of having presented to them so clearly, tersely and authoritatively the results of many years' experience, and the promise of official action along broadened lines, now possible because of the increased authority of the Interstate Commerce Commission.

Many years have passed since its memorable report on the subject of block signal systems and its tentative suggestions in the matter of "auxiliary" or "automatic" train control, a period chiefly distinguished by the plethora of ineffective devices put forward and the supineness of the railroads in meeting the increasingly forceful recommendations of the Commission, made necessary because of the continuing recurrence of fatal collision accidents.

Many of the proposals advanced were but the hasty outcroppings of illy-considered and hair-brained projects by inventors whose pau-

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city of signal and braking systems and practice, as well as railroad operation, were only equalled by a supreme confidence in their devices as universal cure-alls for railroad ills, well expressed in the following naive declaration which precedes the claims of an early inventor:

> "I am aware that combinations of electric apparatus for preventions of accidents on railways have been invented in this and other countries, but I am not aware of their being used to any great extent; but I do not believe that there has ever been invented in this or any other country a combination similar to mine."

Probably not, and hence it is small wonder that railway officials gave little heed to their claims, or even to the general subject. Most of these schemes died aborning because of their innate uselessness, fortunately accentuated by lack of capital, for a quick and early death is the merciful outcome of most inventions.

Yet I doubt if the multiplicity and picturesque variety of automatic train control devices surpass those proposed for railway signal systems, the bewildering character and number of which have occupied the unwilling attention of signal engineers.

But in these latter years there have been many conscientious and able attempts to solve the admittedly difficult problems of auxiliary train control to meet the increasing demands of railway transportation, and some millions of money have been spent, not always wisely, in furthering projects which had promise of, and have achieved, at least a fair measure of success.

To make the path of progress a little more thorny, various arbitrary requirements have from time to time been laid down as either desirable or essential to automatic train control, some of them confessedly included in the latent hope of making success extremely difficult, if not impossible.

The resulting picture was a combination of infallible character which should comprise all the virtues and none of the defects of the ablest operating intelligence of a super-man, signal equipment of undoubted chastity and a brake system guiltless of lapses of mechanical morality, regardless of the fact that what was required was not an automatic automaton in the place of an engineer, but an auxiliary system of train control which, while protecting his train and re-enforcing his intelligence, would leave him practically undisturbed in the handling of his train so long as he performed his duties.

But the fault has not been entirely with the inventors who have tried, however ineffectually at times, to respond to a pressing need in railroad operations to remove the stigma so often, and often unjustly, attached to American railway practice. The responsibility for failure to make greater progress than has attended this development must in considerable measure be laid to the attitude of some of those in position of authority who have successfully discouraged all forward-looking efforts.

Most of those who have been loudest in their expression of disbelief in the possibilities of auxiliary train control simply do not know the facts; and, whether because of technical shortcomings, lack of time, or absence of financial backing, having been unable to solve the problem, they not only have made no individual progress or contribu-

tion to its solution, but they have been inclined to ridicule what has been done constructively by those who have given intensive study to this subject.

They have been wont to revel in the difficulties of railroad operation and to surround it with a cloak of mystery, while assailing the mind with statistics showing the number of billions of ounce-inches moved for each million dollars loss or lives sacrificed. But statistics are a dry menu for the widow and orphan, and as to the victim himself his loss is one hundred per cent.

I am not in entire accord with suggestion frequently made that the solution of the problem is the province of the operating officials of the various railroads, with their many conflicting ideas and practices as to signal equipment and train operation, but rather, as in the progress of signaling and the braking, it is a problem to be developed along catholic lines in such fashion as to marry together any kind of wayside signal, automatic or manual, and any kind of brake equipment so as to effectually meet the varying conditions of operation imposed by different train make-ups.

Operating officials have their hands full of the daily arduous duties imposed in the conduct of transportation. They have neither the time, and rarely the equipment, for continued and difficult experimental work. They must leave this to others who with ample means can devote their whole energy and time to new accomplishments, towards which their attitude must be that of constructive critics.

They can, of course, be of the utmost value and usefullness in that role, and their active and cordial co-operation is vital to final success. The practical question is: Are they prepared to see the coming light and devote that same zeal and conscientious effort which has distinguished their work as signal engineers to the advance of that which will round out and complete their work?

If I read the law aright and the authoritative statement of its representative means what it says, then the plain issue which has to be faced is whether the government shall promptly receive the co-operation from the railroads which it has invited, or whether they will be forced to yield compulsory obedience to mandates arrived at without that co-operation.

Is it necessary to emphasize this fact—that this necessary improvement in railroad operation must, as have many others, proceed despite all opposition? If so, permit me to quote from Mr. Borland's paper:

> "Railroads should be given to understand that the automatic train stop must be developed by them as rapidly as possible."

This was the dictum of the Block Signal & Train Control Board some eight years ago, a period which has been marked by reiterated expressions of this need by the Interstate Commerce Commission, which have finally given the necessary authority by Congress to enforce its recommendations. Tonight, expressing their authority and intent under this law, he states:

> "The period of experimentation has passed; the necessity for automatic train control has been established and the question as to practicability has been answered in the affirmative."

"The administration of this section, of the law (Section 26) is now before the Commission for consideration, and plans for carrying out its purposes are being formulated. It is the purpose of the Commission shortly to inaugurate the work of further developing available train control devices, looking to their practical use by railroads in locations which may be decided upon by tentative authority and to this end, it has invited the co-operation of the American Railway Association."

And again,

"The administration of Section 26 of the Interstate Commerce Act will inevitably result in great strides in the development of the art of automatic train control, and I confidently anticipate that, as suggested by the Block Signal & Train Control Board in 1911, we shall shortly have in service adequate installations of automatic train control devices which will permit an engineman to handle his train without interference as long as he does so properly, but will intervene to stop his train if he disregards the stop indications of an automatic block signal, or runs at excessive speed where speed restriction is prescribed."

In view of these specific declarations, based on a law enacted to empower the Interstate Commerce Commission to make effective its many recommendations, it is difficult to see how even the most cynical disbelievers in, and opponents of, auxiliary train control can long permit in an attitude of active obstruction.

They cannot, as a matter of fact, do so without belittling the findings of the Commission and challenging the specific authority of State and Nation, backed by an awakening sense of public sentiment, while incurring a moral responsibility for loss of life and property which railroad men naturally wish to avoid.

Freely admitting the justice and constructive value of many of the criticisms, even against operative system, by those in authority, and also the compelling necessity of many of the requisites which have been enumerated, I am of the opinion that there are many possible characteristics which rank in at least equal importance with the majority of them, a fact which the report of the late government automatic train control committee seems to emphasize in its comments upon speed-control, to say nothing of the operative demands which alert critics have imposed on my own development.

GENERAL REQUISITES:

I have, therefore, adopted certain basic requisites which seem to me fundamental for the highest measure of success to meet the increasingly difficult conditions of the railroad operation.

Specifically, a system should:

(a) Be applicable to any single or multiple track railroad, with or without automatic signal equipment; and in the case of the former regardless of whether AC or DC normal danger or normal clear signals are used, with or without interlocks and overlaps.

(b) Be suitable for any road regardless of the kind of power used, whether steam or electric; and in the latter

case uninfluenced by the kind of current or type and location of conductors.

(c) Not encroach upon the clearance lines of rolling stock or track equipment, or be limited by extraneous equipment along the right-of-way.

(d) Be unaffected by extremes of climatic conditions, and the track and engine equipments proof against interruption by water, snow or sleet.

(e) Provide distinctive cab signals and full block protection, the same as signals which give both caution and home indications.

(f) Provide speed limitations, regardless of signals, on tangents and curves where required, and insure slowing down to safe running speeds on entering a caution block.

The engine equipment should be:

(g) Readily applied to all types of road engines, passenger and freight, and once installed be a matter of least concern to the engineman in the matter of adjustment, upkeep or replacement.

(h) Unaffected by shock, jar and vibration and proof against roadway dust and changes in atmospheric humidity.

(i) Readily replacable, at least as easily as the standard parts of regular brake equipment.

(j) Of such character that a locomotive can be used interchangeably on all kinds of train service, and with double service or service and emergency braking, as may be required.

(k) Subject to speed control, that is, the forces effecting train stoppage, represented by momentum due to speed and braking power of equipment, should be co-ordinated.

(l) The engine as well as track equipment should be as nearly as possible fool-proof, and demand the minimum of upkeep and attention, both as to time occupied and special knowledge required; and all necessity for adjustments, or even the possibility of such by the engineman be eliminated.

(m) Finally, the system should be for the engineer a friendly mentor and guide, aiding not opposing him, a thoroughly reliable but unobtrusive partner in the operation of his engine, which while at all times interposing an effective shield between him and disaster, will leave, within all proper limits, the handling of the train subject to his judgment.

Can these results be obtained?

I think I can safely answer in the affirmative, from my own experience, one which represents many years of co-operative work, including constructive advice and suggestions by well known experts in braking and signalling, and the expenditure of many hundreds of thousands of dollars.

Time does not permit detailed description of the equipment which has thus been developed, and I will content myself in simply stating certain facts, leaving to those who wish detailed information the privilege of acquiring such by personal inspection and demonstration.

In case of failure of current supply and consequent automatic action of brake the equipment can be rendered inactive, so that normal control of locomotive and brake will remain, but this cutout is self detecting.

Finally, the total equipment on the locomotive bulks less and is simpler than the lighting and braking equipment individual to a single trail car on a modern passenger train.

All this sounds as if we had something. We have, and it is now possible for doubting Thomases to ascertain the facts if they really wish to know them.

Discussion of Automatic Train Control

CALVIN W. HENDRICK*

Train control has been under discussion for the last fifteen years. Committee after Committee have been appointed, each drawing requisites more severe than the previous one, until the Government has now made train control part of a new transportation act. I presume that you gentlemen feel that sufficient time has passed to want to know if any definite action has been taken by a railroad itself in making installations and what are the facts.

The following data will answer this inquiry in a most concrete way:

In developing train control, we have concentrated on solving the following problems:

1. Meeting train movements on single track without reducing the capacity of track.
2. Reducing the obstructing of roadbed to a minimum by the use of ramp rails only 40 feet in length, from which both automatic and cab signals are operated.
3. Controlling speed of train by electrically operated speed control, in place of speed control operated by mechanical means.
4. Reducing to a minimum the time consumed in stopping and starting a train when stopped by automatic application of brakes.
5. Producing an equipment that will stand up under the constant rough usage of regular service operation (having only one moving part).
6. Transmitting condition of track circuits into engine cab with lights with whistles to call attention of engineer.

A Committee was appointed on one railroad to conduct tests, consisting of the heads of the various operating departments, who outlined the following requirements that would have to be met:

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*President, Automatic Train Control Corporation.

> If dangerous conditions exist, trains must be brought to a stop by a satisfactory service application covering both passenger and freight trains up to 100 car lengths.
>
> Must operate in connection with wayside signals on either double or single track.
>
> Must give proper signals whether the train is moving forward or backing.
>
> On account of fog and weather conditions, an audible as well as a visual signal must be given in the cab to conform to the wayside signals.
>
> Must not interfere with the application of the brakes by the engineman's brake valve, and must work in conjunction with either ET-5 or ET-6 air brakes.
>
> Must allow two or more engines coupled together and operated only on the engine from which the brakes are controlled.
>
> Must be so arranged that if stop shoe is injured, caution shoe becomes stop shoe by throwing switch.
>
> These conditions having been met, seven miles of single track, main line, were equipped, also 32 engines, with your automatic stop, cab signal and circuit reverser.
>
> After testing the system out under service conditions nearly a year, working under weather conditions when the stop shoe was entirely encased in ice, trains have been stopped when the following dangerous conditions prevailed: Open Switches, Block Occupied by Train, Cars fouling the main line, Broken rails on three occasions. This would seem to justify the cost of installation.

Our eletrical speed control allows a train to pass a stop rail without receiving a stop, provided the speed of the train is reduced to a pre-determined speed (but only at such point as are decided on, such as long trains ascending heavy grades—cross overs, sharp curves, etc., where the speed of the train should be reduced.

We had made a special point of not taking control of the train out of the engineer's hands until he has had every opportunity to obey the signals in order not to reduce the capacity of tracks by slowing down or stopping the trains except as a last resort, as the home signal often clears up immediately after the train has passed the distant caution signal. If the control of the train has not been taken out of the engineer's hands when he passes the distant caution signal, he can at once pick up the speed of his train without being held down until he reaches the home signal.

Allowing a train to pass a stop rail at a pre-determined speed has many advantages in operation and is in accordance with the stand taken by Mr. Borland, Chief Inspector of the Interstate Commerce Commission, as expressed in his remarks before the Railroad Club of New York on April 9, last, as follows:

> "We all know that automatic signals are stop and proceed signals. The interlocking signal is what is known as a stop and stay signal, but the automatic signal is a stop and proceed; and the theory upon which that idea of speed control

touched upon in Mr. Balliet's paper proceeds is that when a man has brought his train down to a safe speed, which is pre-determined, at any point protected by a stop and proceed signal, it is just as safe for him to pass that signal at a speed of, say, five miles an hour, as it is to bring his train to a full stop then proceed, because the rules permit him to proceed, just as soon as he has brought his train to a stop, and if he brings his train down to a safe speed, it is quite proper to permit him to go on under those conditions."

Some of the results obtained after a series of tests, are as follows:

The elimination of the Manual Block.

A considerable increase in train movements.

A large decrease in overtime for train crews.

A four-minute interval with clear "block" for following movements.

A positive check on automatic block signals, besides we have eliminated our chance of participation in the six per cent of fatalities which the Automatic Train Control Committee includes in their report.

In conclusion, the matter boiled itself down to:

1. Have the most difficult operating conditions been satisfactorily met (we claim single track movement is the most difficult, and 85 per cent of the main lines are single track) ?
2. Has any railroad given a bona fide contract after testing out a system under their own officials?
3. What do railroad men say about train control? In other words, "the proof of the pudding is in its eating."

Waste Heat Utilization

By G. R. McDermott and F. H. Willcox

Presented November 15, 1920

The term waste heat is inclusive of the total heat left in gases of combustion when they have served their primary purpose of roasting, reducing, oxidizing or heating in industrial or metallurgical furnaces or kilns. Furnaces employing regeneration or recuperation commonly have left in the gases of combustion, leaving the furnace from 35 to 55 per cent of the total heat available in the fuel fired. Non-regenerative furnaces may have as high as 80 per cent of heat in the fuel escaping in waste gases of combustion. Kilns, oil stills, glass tanks, water gas sets, etc., all present, on account of the amounts and temperatures of escaping gases of combustion, amounts of waste heat that are not only recoverable but that give returns which will net from 25 to 75 per cent in one year on the installation cost of the equipment.

The past two years have seen marked increases in the price of fuel and it behooves all concerned to utilize the waste heat which may be available not only as an individual economy but a conservation of the national resources.

This paper has particular reference to the development of waste heat fire tube boilers for open hearth furnaces. The application is of particular interest to this Society for the reason that it was at the Illinois Steel Company, South Chicago, that the very first studies were made and the first successful applicaton of waste heat boilers for open hearth furnaces was effected. The first installation was operated in 1910, and upon the very important discoveries then made have been based the rapid developments and applications of modern waste heat boilers.

It is to be noted that prior waste heat boiler installations had to do with waste gases at temperatures of 1600° Fahrenheit and higher. It had hitherto been considered impracticable to generate steam commercially with gases below this temperature. For waste heat boilers prior to this time the accepted deviation from hand-fired types was an increase in the gas passage area. The work of Mr. C. J. Bacon, formerly Steam Engineer, Illinois Steel Company, South Chicago, demonstrated that for gas temperatures under 1600°, the gas passages should be decreased and as a corollary the velocity of gases increased.

The authors trust that some specific figures tracing the origin, work and amounts of waste gases and principles of their utilization after the furnace, will be a more lasting contribution to the records of the Society.

SOURCE OF GASES FROM AN OPEN HEARTH FURNACE
TYPICAL HEAT DATA

Size of heat	75	tons (ingots)
Tons hot pig iron charged	42.75	"
" cold pig iron charged	.57	"
" iron scrap charged	6.10	"
" steel scrap charged	32.50	"
Pounds ore charged	14,200	lb.
" limestone charged	15,100	"
" dolomite charged	5,265	"
" fluorspar charged	762	"
" silicon (10%) charged	262	"
Tons coal charged at producers	23.7	tons

Time of heat	9 hr. 25	min.
CO content of waste gases	13.0	per cent
Temperature of waste gases from checkers	1,300	deg. F.
Heat value of coal	10,800	B. T. U.
Percentage pig iron	56.0	
" scrap	36.8	
" ore	7.2	

The gas producing elements of the charge are the pig iron with 4.35% carbon, 0.85% silicon and 1.75% manganese; the limestone with 42% carbon dioxide; and the coal with the following analysis:

ANALYSIS (NATURAL)

Carbon	60.10	percent
Hydrogen	4.36	"
Nitrogen	1.18	"
Oxygen	10.97	"
Sulphur	1.42	"
Ash	8.43	"
Moisture	13.54	"

The steel scrap charged is considered a neutral component, being essentially of the carbon and metaloid content of the steel produced. The dolomite and fluorspar contribute negligible amounts of carbon dioxide to the gases. The ore charged, averaging 89% ferric oxide, is significant in that the oxygen available therein for combining with the carbon of the pig iron reduces the amount of air with its nitrogen diluent, otherwise required for oxidation.

To reduce the data to pounds of gas per hour available for steam generation, the open hearth practice must be reduced to the following figures:

Rate steel produced per hour	7.96	tons ingots
Coal per ton ingots	701	lb.
Ore per ton ingots	189	lb.
Pig iron per ton ingots	1,475	lb.
Limestone per ton ingots	200	lb.
Silicon	3.5	lb.

Gas from pig iron charged per ton steel:

4.35 (carbon in pig iron) less 0.20 (carbon in steel)=4.15 percentage carbon burned out of pig iron.

$1475 \times .0415 = 61.2$ lb. carbon burned out of pig iron.

$61.3 \times 2.666 = 163.0$ lb. oxygen required for carbon.

$189 \times 0.265 = 50.0$ lb. oxygen available in ore.

$163.0 - 50.0 = 113.0$ lb. oxygen required from air.

$113 \times .768 - .232 = 375$ lb. nitrogen in gas from accompanying oxygen.

$61.2 + 163.1 = 224.3$ lb. CO_2 from pig in gas.

Gas from limestone charged per ton steel:

$200 \times .042 = 84$ lb. CO_2.

Gas from silicon and manganese charged per ton steel:

$1.75 + .85 = 2.60$ percentage silicon and manganese in pig iron.

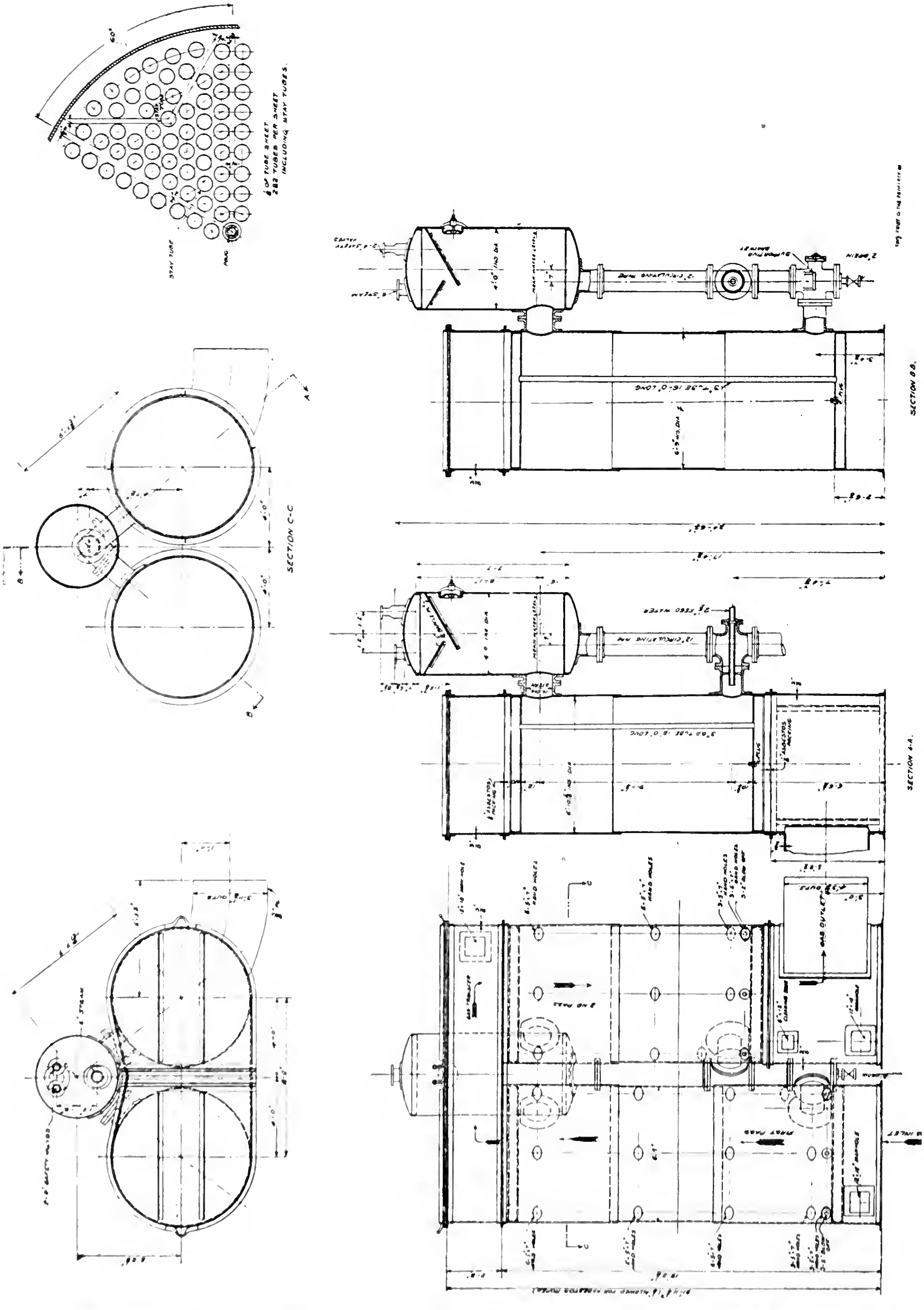
$1475 \times .026 = 38.5$ lb. Mn. and Si. in bath.

$38.5 \times 0.8 \times .768 - .232 = 102$ lb. nitrogen in waste gases from oxidation of Si. and Mn.

Total carbon dioxide from charge=308 lb.

Total nitrogen by charge=477 lb.

Cases from coal burned at producer:



Bacon two pass fire tube boiler for waste heat 82"x5700 Sq. Ft. boiler. General Arrangement

$11.52\ C$ plus $34.56\ (H - \frac{O}{8})$ plus $4.32\ S =$

$11.52 \times .601$ plus $34.56\ (.0436 - \frac{.1097}{8}) = 8.01$ lb. air required per lb. coal.
plus $4.32 \times .0142$

Analysis burned gases (0.0% excess air)
CO_2 $.601 \times 3.67 = 2.2$ lb. CO_2.
O_2
N_2 $8.01 \times .768 = 6.15$ N_2 from air.
.15 N_2 from coal.
H_2O $.0436 \times 9 = .39 H_2O$ from H in coal.
$.1354 H_2O$ from coal.
.07 H_2O from air at 75% humidity.
.50 H_2O from steam.
9.59 total weight gas per 1 lb. coal.
$701 \times 9.6 = 6730$ lb. total weight gas from coal per ton ingots.

Percent by weight:	Wet.	Dry.
CO_2	22.85	25.8
N_2	65.75	74.2
H_2O	11.40	

ANALYSES OF TOTAL WASTE GASES—NO AIR DILUTION—
PER TON INGOTS.

			Analysis—Dry. Weight.	Volume.
CO_2 From Charge	308 lb.			
From Coal	1540 lb.			
Total		1848 lb.	27.4%	19.2
N_2 From Charge	477 lb.			
From Coal & Combustion	4416 lb.			
Total		4893 lb.	72.6%	80.8
H_2O From Coal and Steam	768 lb.	768 lb.		
Total weight of gases per ton ingots		7509 lb.		

The CO_2 content of 13% in the stack gases as compared to 19.2% in gases from charge and coal undiluted with air indicates an addition of air of 47.5% to the gases. This is in part supplied through the ports and in part by leakage at the doors, ports and checkers. The indicated addition of 47.5% air to 7509 lb. gas will total 3591 lb. of air per ton of ingots, giving 1848 lb. CO_2, 833 lb. of Oxygen, 7651 lb. Nitrogen, and 768 lb. Moisture, or a total weight of gases of 11,100 lb. Per hour we have 88,500 lb. of gas. As an approximate check on these quantities of gas one may divide the total carbon in coal, pig iron and limestone, or 503 lb., by the carbon in one cubic foot of waste gas containing 13% CO_2, or 0.044 lb. This gives us 91,000 lb. per hour.

At 1300° F. there are 26,000,000 B. T. U. in the waste gases, as against 60,000,000 B. T. U. in coal charged, or 43% of total heat charged, equivalent to 2400 lb. of coal per hour. As will be seen, 1270 lb. of coal equivalent can be recovered per hour in a waste heat boiler.

Having the quantities and temperature of the available gases, the boiler design required to utilize them may be described. It may not be without interest to review the heat and absorption phenomena obtained in a direct fired boiler and in the considered case of waste heat boiler. Many experiments have shown that the heat absorbed by radiation is proportional to the fourth power of absolute

temperature difference between the radiating surfaces. Contrasting a stoker-fired boiler with combustion temperature at 2700°, and waste heat boilers at 1300° initial temperature, the absorption by radiation factor would be as

$$\frac{(Tc)^4}{(Tw)} = \frac{(2700 \text{ plus } 460)^4}{3160^4} : \frac{(1300 \text{ plus } 460)^4}{1760^4}$$

or

$$10.5 : 1$$

The absorption by radiation in the case of the direct fired boiler will be ten times as great as in the case of the waste heat boiler.

Ordinarily about 65% of total evaporation is by radiation and 35% by convection, so that on a 600 H.P. boiler, 7,025,000 heat units are absorbed by convection and 13,050,000 heat units by radiation. In the waste heat boiler but 1,300,000 heat units can be absorbed through radiation, leaving 18,700,000 to be absorbed by convection. Ovbiously the rate of heat transfer by convection must be, for the waste heat boiler, 2.75 times greater per square foot of heating surface.

Even this hypothetical ratio does not state the handicap imposed upon waste heat boiler heat absorption because the heating surface exposed to the direct heat of the furnace is less than in the case of a direct fired boiler. Obviously for a given gas weight, starting in with an initial temperature of 2700° F. and 1300° F. respectively, passing through or past an identical heating surface of a boiler, and having identical exit temperatures, the net amount of heat absorbed by convection by the heating surface must be much greater for the waste heat boiler with initial temperature of 1300°. Per square foot of heating surface of the boiler, therefore, the heat transferred by convection must jump to a figure hitherto considered impracticable. This point of view is not always appreciated. It is not infrequently felt that since a low temperature waste heat boiler gives but 70 to 80 percent of builders' rating that the heat transfer rate is low. Actually it is very high.

An increase in heat transfer rate is accomplished by an increase in velocity. Consideration of the formulae governing this phenomena will develop the reasons.

The rate of heat transfer for either fire-tube or water-tube boilers may be expressed in the form

$$R = \frac{H}{T-t} = a \text{ plus } \frac{bW}{A}$$

where R = B. T. U. per hour per degree mean temperature difference per square foot tube surface swept by gases.

H = B. T. U. transferred per hour per square foot

T = Mean temperature of gases (logarithmic)

t = Temperature of tube wall, usually taken as temperature of water in boiler

a = and b = constants.

$\frac{W}{A}$ = Mass velocity, usually expressed as pounds of gas per hour per square foot of area for passage of gases.

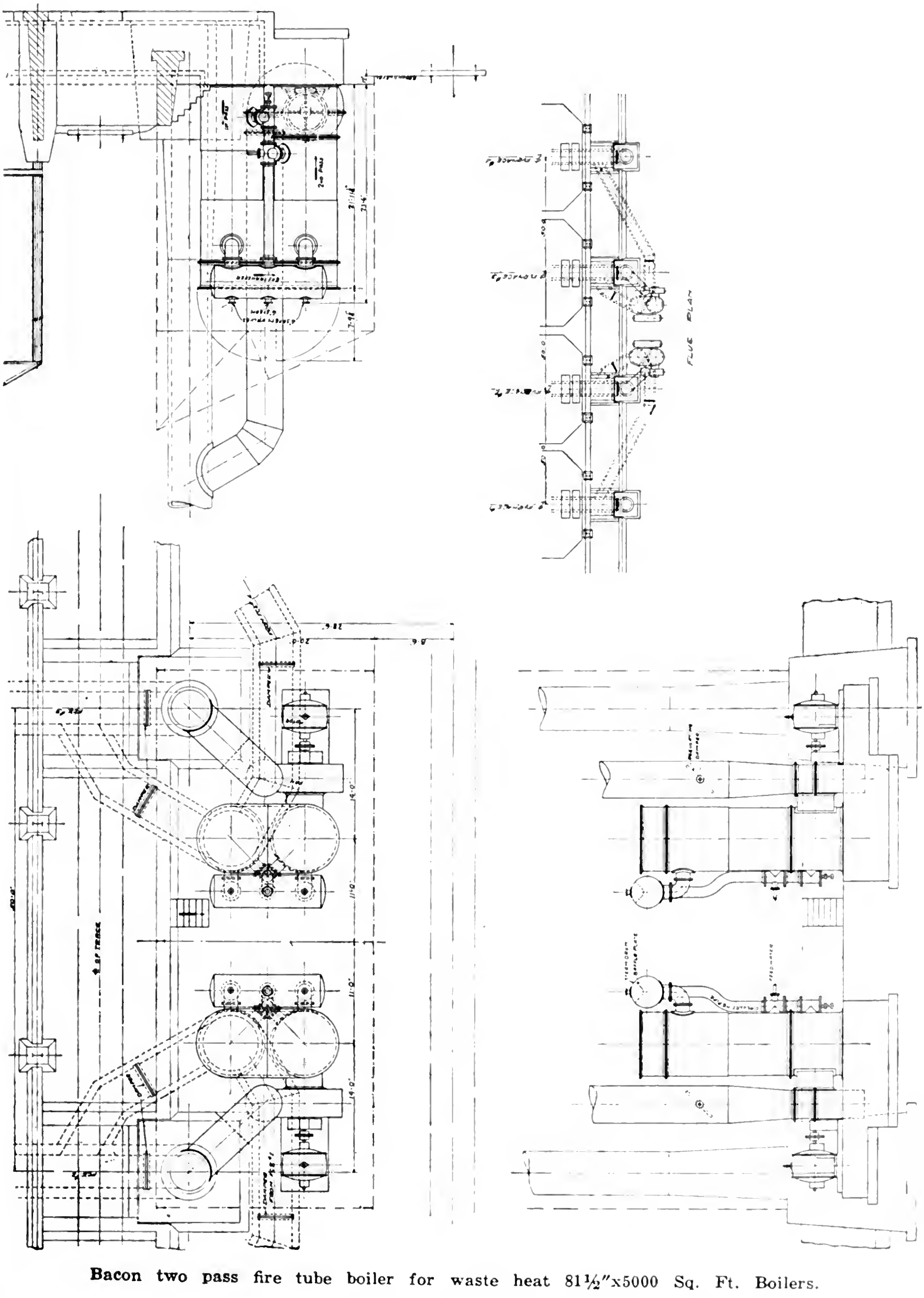
In general the constant *a*

(1) is greater for water tubes than for fire tubes of same size,

(2) is greater as diameter of tube decreases,

(3) is greater as space between water tubes decreases.

Similarly, constant *b*, which is the inclination of line representing R when plotted against mass velocity,



Bacon two pass fire tube boiler for waste heat 81½"x5000 Sq. Ft. Boilers.

(1) is greater for water tubes than for fire tubes,
(2) is greater as diameter of tube decreases,
(3) is greater as temperature difference between steam and water increases.

For the constants *a* and *b,* values may be assigned that are sufficiently accurate for all ordinary engineering applications and are derived from reliable tests and investigations conducted by boiler companies and independent observers.

For the purpose of this paper, the following formulae are given as they illustrate the relative heat absorbing characteristics of the two types of boilers, the data being taken mainly from tests made by the Babcock & Wilcox Company on both fire-tube and water-tube boilers, by Messrs. Kreisinger and Ray, on small fire-tubes, and confirmed by tests on two-pass waste heat boilers later described in this paper.

Outside Diameter of Tubes—Inches	Fire Tubes	Water Tubes
1	$R = 3.5 \text{ plus } .0013\frac{W}{A}$	
2	$= 2.0 \text{ plus } .0008\frac{W}{A}$	
3	$= 1.5 \text{ plus. } 00065\frac{W}{A}$	
4	$= 1.1 \text{ plus } .0005\frac{W}{A}$	$R = 2.0 \text{ plus } .0014\frac{W}{A}$

These values apply 400 deg. F. mean temperature difference corresponding approximately to waste heat boiler conditions.

The two most important requisites in proportioning boilers for a given amount and temperature of waste gas are high rate of heat transfer and a low draft loss. Both depend on mass velocity, but the latter varies as the square of the velocity. A boiler arrangement designed for attaining a high transfer rate must be compromised to keep the friction loss within economical limits.

It so happens that whereas the water-tube boiler at a given mass velocity and tube diameter has a higher heat transfer rate than the fire-tube type, nevertheless the friction loss in the fire-tube boiler is much less.

Because of this low friction loss, the mass velocity may be raised and consequently the rate of heat transfer may be so increased as to exceed that obtained in the water-tube type, while keeping the friction loss the same. To llustrate this point, figures are here presented showing that a fire tube boiler may be designed that will have less than one-half the heating surface of a horizontal cross-baffled water-tube boiler, and still give the same performance under the same operating conditions. As a basis for comparison, an average size of standard type of water-tube boiler and operating conditions are taken from actual practice.

Published results of tests on seven waste heat boilers, all of similar horizontal water-tube type with 4-inch tubes and cross baffling, show the following averages:

Rate of heat transfer—B. T. U.—	5.32
Draft loss—ins. water—	1.45
Heating surface—sq. ft.—	5,030
Weight of gas—lb. per hr.—	68,330
Initial temperature—deg. F.—	1,330

Stack temperature—deg. F.—	470
Boiler H.P. — —	400

These figures indicate in a general way what may be expected from specially adapted types of water-tube boilers as ordinarily installed and operated. The mass velocity corresponding to the above average heat transfer rate, as computed by formula $R = 2 \text{ plus } .0014 \frac{W}{A}$, is 2,370 lb. per hour per square foot of passage area.

For the sake of comparison, let us consider some fire-tube boilers so proportioned that the same amount of gas will cause the same loss of draft; viz., 1.45 inches. Tube sizes are assumed as 1, 2 and 3 inches diameter as this selection illustrates the superior advantages of using small tubes. Three cases are worked out as follows:

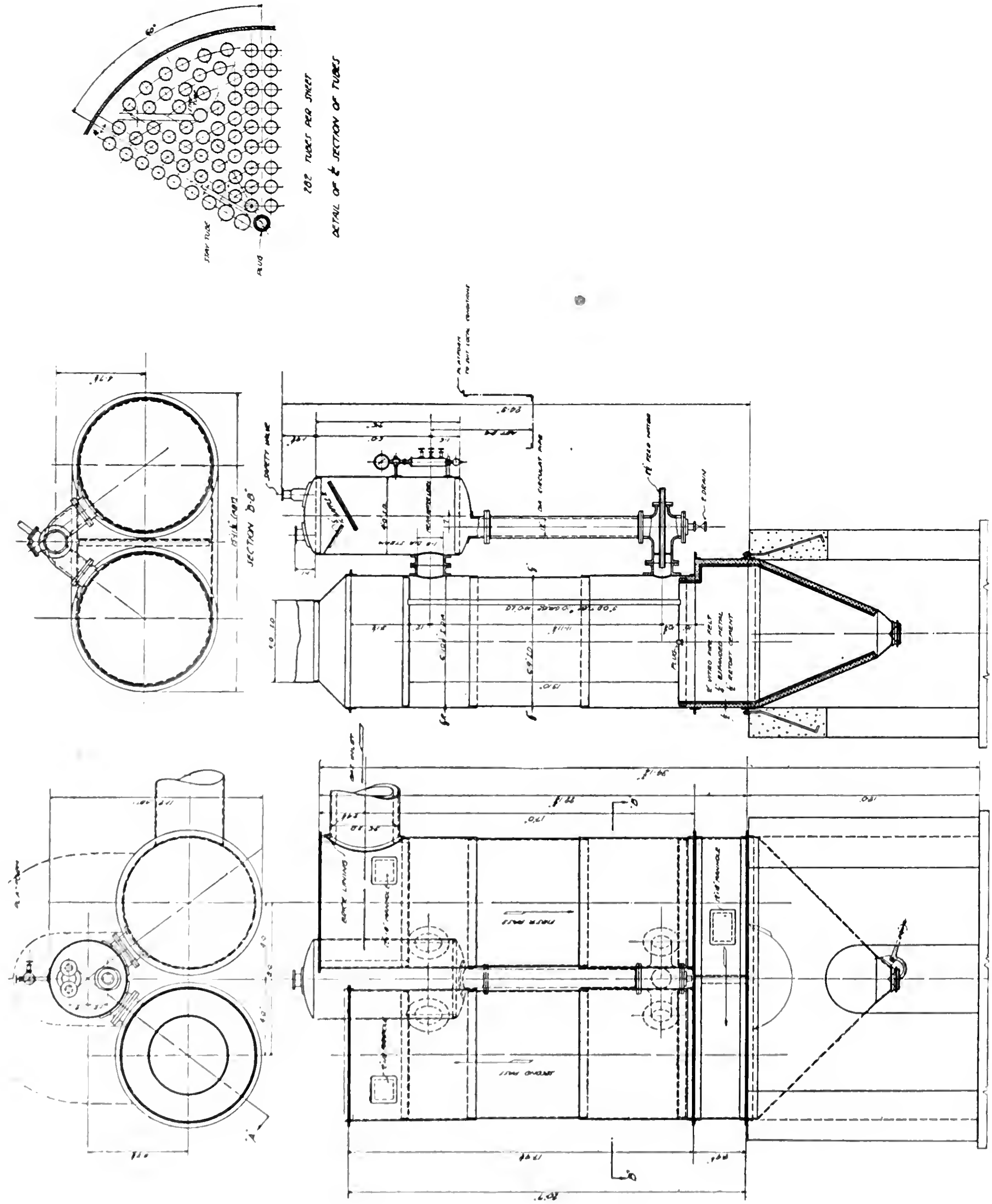
Type of Boiler:	Horizontal Water Tube.	Double Pass Fire Tube.	Single Pass Fire Tube.	
Size of tubes, outside diameter	4-in.	3-in.	2-in.	1-in.
Number of tubes		282	525	1,830
Length of tubes—ft.		28	14	5
Heating surface—sq. ft.	5,030	5,700	3,400	1,960
Weight of waste gas—lb. per hour	68,000	68,000	68,000	68,000
Mass velocity—lb. per sq. ft.	2,370	5,900	8,000	8,500
Rate of heat transfer—B. T. U.	5.32	5.34	8.4	14.6
Draft loss—ins. water	1.45	1.45	1.45	1.45
Initial temperature—deg. F.	1,330	1,330	1,330	1,330
Stack temperature—deg. F.	470	470	470	470
Boiler H.P.	400	400	400	400

Inasmuch as the rate of heat transfer at high mass velocity varies almost in proportion to the mass velocity, it is obvious that the number of tubes may be decreased without materially affecting the evaporation. This greatly reduces the first cost and the only disadvantage—if indeed it be a serious one at all—is the increase in friction loss. For example, the evaporation obtained in the boiler with 1,830 one-inch tubes, 5 feet long, may be equally well obtained with only one-half the number of tubes by merely increasing the length to 5.25 feet as

Size of tubes	1 inch O. D.
Length of tubes	5.25 feet
Number of tubes	915
Heating surface	1,130 sq. ft.
Weight of gases	68,000 lb. per hour.
Mass velocity	17,000 lb. per sq. ft.
Rate of heat transfer	25.5 B. T. U.
Draft loss	6.15 inches.
Initial gas temperature	1330 deg. F.
Stack temperature	470 deg. F.
Boiler H.P.	400.

The greater friction loss may be compensated for by increasing the length of tubes so as to obtain sufficient additional evaporation to carry the greater load on the fan.

The point is often raised that tubular boilers are not so efficient as water-tube boilers. This is perfectly natural when only the usual types of tubular boilers and methods of using them are considered. As a matter of fact, the



Bacon waste heat boiler 82″x5700 Sq. Ft.

heating surface of tubular boilers can be made as effective or even more so than that of water-tube boilers. The trouble with the usual fire-tube boiler, especially when used for waste heat applications, is that the area for the passage of gases is too large and there is not sufficient length of travel for the gases. These objections are, of course, overcome by making a long boiler of small diameter or, what amounts to the same thing, dividing the boiler into two or more passes. The matter of tube size is also a large factor and if the question of cleaning were not of such real importance, the tubes could to great advantage be as small as locomotive tubes or even smaller. Waste heat boilers used in Europe in connection with gas engines have tubes of only an inch or so in diameter.

By thus increasing the velocity of gases over the heating surface, the rate of heat transmission may be raised to a point as high or even higher than exists in the case of water-tube boilers. Velocity is usually expressed as weight of gas per hour, divided by the area of gas passage in square feet.

It is evident that for the same mass velocity the water tube gives the higher rate of heat transmission but the important point is that the mass velocity in the fire tube boiler may be much higher without an increase in draft loss. For example, the average of tests on nine waste heat boiler installations, using cross-baffled water-tube boilers having 4-inch tubes, shows:

Mass Velocity	Rate of Heat Transmission	Draft Loss
2440	5.42	2.07

If a two-pass fire-tube boiler with 3-inch tubes were used, the conditions would be:

7630	6.45	2.07

It is thus evident that for the same draft loss, the fire-tube boiler may have a higher mass velocity and give a higher rate of heat transfer than a water-tube boiler of the type above mentioned.

It is frequently assumed that any type of boiler that gives good results when fired with coal, or other fuel, will likewise be a good one for waste heat utilization. In most instances, however, this is not the case. There are certain conditions that are more or less characteristic of the operation of construction of industrial furnaces which make it uneconomical and otherwise inadvisable to use standard boilers.

The Bacon Waste Heat Boiler is designed to utilize at the maximum net economy the heat in waste gases from metallurgical and other industrial heating furnaces. It possesses special features that have been found to make it particularly well adaptable to the conditions peculiar to the majority of applications. The initial installations were in conjunction with open hearth furnaces in steel works where the operating conditions and other limitations interfered with obtaining satisfactory results from standard types of boilers.

Obviously, in order that the first cost may be low and that the boiler may have the desired evaporative capacity, it is essential that the design contain such features as to permit condensing the heating surface into the smallest possible space. This in turn requires that the rate of heat transmission through the heating surface be proportionately high. Data resulting from various authoritative tests makes it possible to predict with accuracy what the heat transmission, and consequently the evaporation, will be.

The three conditions conducive to high heat transfer rates are:

(a) High velocity of gases.
(b) Small size of boiler tubes.
(c) Clean heating surface on both the water and gas sides.

As usually built, the Bacon Boiler consists of two vertical cylindrical shells,

between the heads of which are rolled and electrically welded a large number of small tubes in a similar manner to vertical fire tube boilers. The diameter of tubes is kept as small as permits cleaning and the length is determined mainly by the space available and the friction loss. The object is to insure that the gases have a long travel at high velocity. In some cases it is found desirable that the average velocity exceed 100 ft. per second for the purpose of preventing dust from lodging and to give a high rate of heat transmission. The waste gases enter the gas box at the bottom of the first pass, whence they pass upward through the tubes and into the transfer flue which directs the flow downward through the second pass, and in the case of an installation now under construction a third pass, which will act as an economizer.

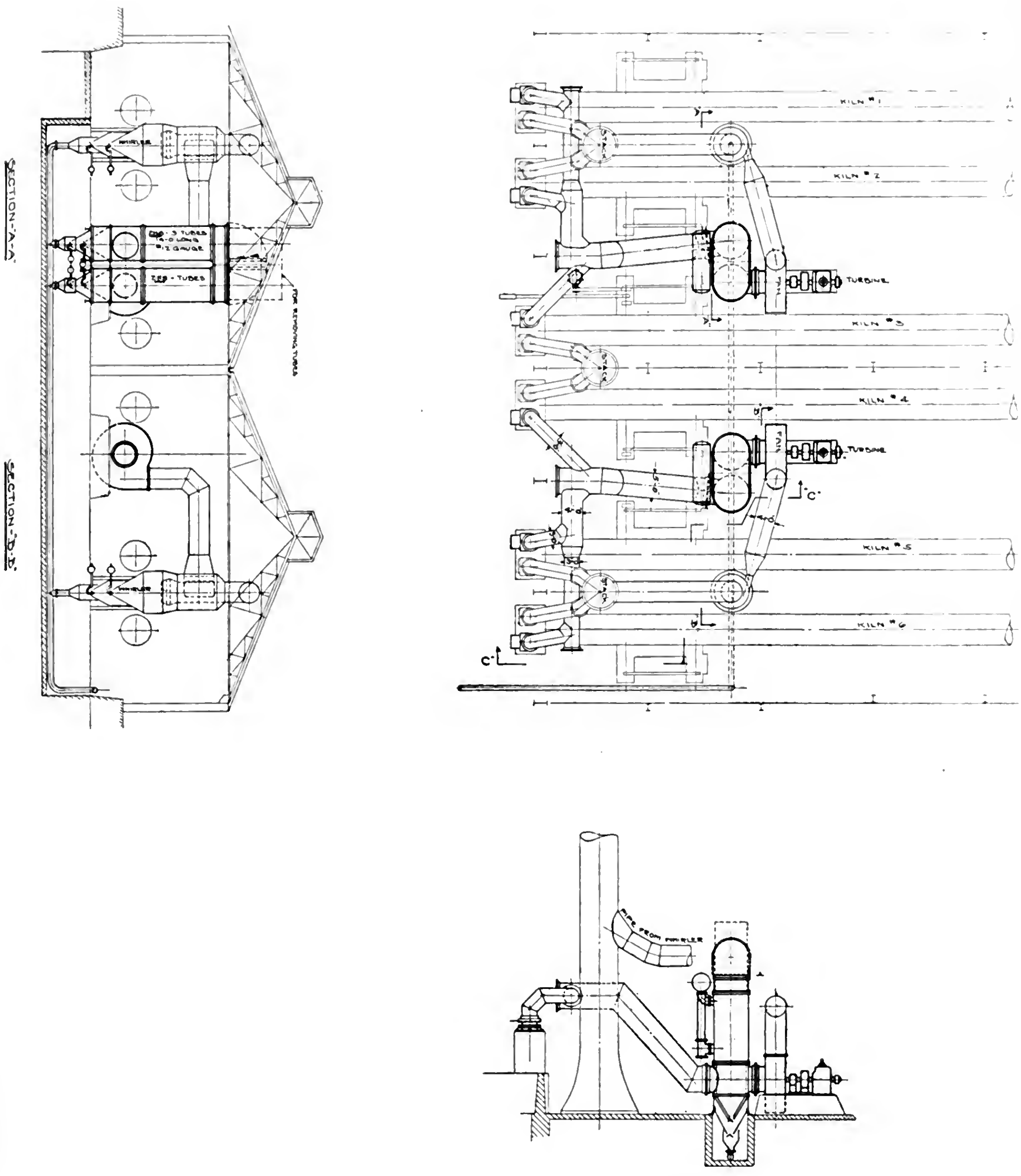
In some forms of construction of the Bacon Boiler a single shell is set horizontally and the two passes are obtained by suitable baffling in the steel plate gas boxes at the ends of the shell. For application to small furnaces this is a better arrangement than the double vertical shell design.

Boiler scale trouble is minimized on account of feed water being admitted at the bottom of the second or "cold" pass. Here it becomes gradually heated and rises to the top of the pass. The water then passes from the second pass through an exterior water circulating connection to the bottom of the first or "hot" pass. As but one-third of the heat is utilized in the second pass, where gas temperatures at the bottom are not over 560 deg., the sludge deposited is not hard and may readily be blown off through the several blow-off connections. The principle of forced water circulation on a counter-current principle gives a high rate of heat transfer. Liberal hand-hole access is provided and blow-off valves are arranged to drain the bottom tube sheets.

As a rule, natural draft is not sufficient because the gases leaving the boilers have been cooled to 450 deg. or 500 deg. in the attempt to recover as much of the heat as possible. On this account and because the intensity of draft required for operating the industrial furnaces and for drawing the gases through the boiler, it becomes necessary to use induced draft fans. When properly installed and driven, the fans prove a very advantageous accessory from the standpoint of better control of the operation of the heating furnaces, and with correctly selected turbine drive the exhaust steam suffices to heat the boiler feed water.

While fans are a necessity regardless of the type of boiler used, the amount of power they require is much less with the Bacon Boiler than with water tube boilers in brick settings. It is not at all unusual that the amount of air leakage through brick settings and other loose joints is sufficient to increase the fan load 80 per cent over what it would be without leakage. Moreover, the leakage reduces the evaporation to a serious extent, due to cooling the gases. Thus it is seen that a type of boiler having no brick settings is the logical solution of the air leakage problem. Casing the boilers in sheet steel reduces the trouble but does not stop it since much leakage is past brick-to-metal joints. Moreover, it increases the cost of installation. The great difference in draft that exists in a baffled water-tube boiler on the two sides of the baffles causes short circuiting of gases, through leaky baffles, consequently lack of contact with tube surface and high stack temperatures. With fire-tube boilers trouble of air leakage from exterior or short circuiting of gases through baffles cannot occur. There is no brick work except linings of flues and gas boxes and these are of steel plate construction with well fitted joints.

Explosions in the waste gas flues and in waste heat boilers are characteristic of open hearth furnaces using pre-heated gas. Leakage especially promotes explosions in the boiler setting at times of reversal. These explosions strain the



SECTION-"C-C"

Bacon two pass fire tube boilers for waste heat 81½"x5800 Sq. Ft. Boilers.

settings, loosen the brickwork and increase the air leaks of water-tube settings. As an actual matter of fact, these leaks develop into serious conditions, particularly if repairs are not made promptly in every-day operation. Consequently evaporation falls off continuously and it is a matter of record at many plants that air infiltration is such a serious factor that maintenance of economic steaming and furnace performance is a practical impossibility. Explosions cannot injure the Bacon setting.

The dust from open hearth furnaces and checker chambers is in a fine and adherent condition. It packs closely onto the tubes of water-tube boilers. It is indifferently removed by soot blowers. In the Bacon fire-tube type the dust does not readily collect on the surface of the vertical tubes. The straight vertical tubes are most effectively blown while the boiler is in full operation because with the gases of combustion passing through at high velocity an effective sweeping action takes place. Maintenance of clean tubes is easier in this type than in the water-tube type, which means less draft loss, therefore less power required for the fan, resulting in a higher permanently sustained rate of heat transfer.

Where dusting cannot be done thoroughly, the stack temperatures will be 75 to 100 deg. higher than with a clean boiler. This is a loss in evaporation of 10 to 15 percent. The loss in a waste heat boiler on this account is two and one-half times that in a direct fired boiler. The importance of clean tubes cannot be overstated. Another factor which led to this particular design of the fire-tube type of boiler for waste utilization was its better adaptation to existing space and conditions. It was found with the Bacon type that for equal evaporation it requires but two-thirds to three-quarters of the cubic space required by the water-tube type of boiler.

DESCRIPTION OF TYPICAL INSTALLATION AND EVAPORATION TEST OF A BACON WASTE HEAT BOILER.

The installation consists of fourteen boilers, one Heine, two Stirling water-tube, and eleven Bacon fire-tube boilers. A test was conducted on one Bacon fire-tube utilizing waste gases from an open hearth furnace. Each unit consists of a superheater, a two-pass vertical fire-tube boiler, and an exhaust fan driven by a steam turbine.

The superheater consists of two units with elements set in a vertical position in the horizontal flue near the first pass of the boiler. Capacity 150 deg. superheat, 12,000 pounds per hour, 150 pounds pressure, 98 percent dry, temperature waste gases 1200 deg. F.

The boiler consists of two vertical passes 82 in. in diameter. The first pass contains 282 3-in. flues, 16 ft. long and the second having a like number, but 12 ft. long. The tops of the two passes are set at the same height and each has a 16-in. nozzle located 12 in. from the top flue sheet and connected to a 4-ft. 0 in. x 7 ft. 0 in. steam drum. The bottom of the steam drum, which is about 30 in. below the top of the passes, is connected to each of the two passes near the bottom by a 12-in. water leg. Feed water enters this water leg from which it flows to the bottom connection of each pass. The water level is carried about 14 in. below the upper flue sheet. This gives about 92 per cent of the heating surface as effective for evaporation.

The second pass is equipped on top with a permanent soot blower while a hand lance is used on the bottom of the first pass and super-heater for cleaning flues.

The waste gases are handled by an overhung wheel single inlet fan. Capacity 80,000 lb. of gas per hour at 500 deg. F. with static difference of 5.5 in. at

1115 R. P. M. Efficiency 75 percent, requiring 37.5 H.P. The fan is driven by a steam turbine, standard non-condensing 3985 R. P. M. rated 37.5 B.H.P. The change of speed is made by a set of Herringbone speed reduction gears of 3:57 to 1 ratio. The gases are taken from the main furnace flue, immediately before entering the stack, pass through a horizontal brick flue 4 ft. 0 in. wide by 6 ft. 9 in. high, equivalent to an area of 27 sq. ft., to the super-heater, hence through the same sized flue to directly underneath the first pass, taken up through a 5 ft. 3 in. diameter brick lined flue and through the first pass, then across the transfer flue, down the second pass and out to the fan. The fan discharges the gases back into the main stack again immediately above the roof line. The boiler is equipped with suitable dampers before the super-heater and after the fan to by-pass the boiler.

The feed water passes through a water softener of 15,000 gal. per hour normal rating, located in the vicinity of the open hearth. The exhaust steam from the fan turbines and the three reciprocating feed pumps is used in heating the feed water while passing through the water softener.

EVAPORATION TEST.

Th tests were run on No. 21 boiler—one on June 14th and the other on July 1st.

Feed water was measured in tanks of known dimensions and feed water temperature was taken with a thermometer. Tell-tale valves were put in feed line to avoid any possible error in feed water piping. The blow-off valves all terminate in a pit and this was observed to correct any possible leakage. These valves were tightly closed and no leak found.

Temperatures of gases before the super-heater, between the super-heater and boiler, and between the two passes were taken with thermo-couples which were checked immediately before the tests. The temperature of gases between second pass and fan, also temperature of super-heated steam, was taken with mercurial thermometer.

Drafts were taken with manometers and were checked frequently to avoid error with changes of temperature.

The steam consumption of the fan turbine was obtained by a recording steam flow meter, the nozzle plug of which was installed in the 2½-in. steam line to the turbine. Each test was run from tap to tap of the furnace, but the first two hours of the last test were thrown out on account of having gas turned off for a few minutes due to furnace troubles.

RESULTS OF TESTS.

Date	June 14, '18.	July 1, '18.	
Duration	9 hr. 55 min.	7 hr. 50 min.	
Pressures.		June 14, '18.	July 1, '18.
Steam at boiler	Lb. per sq. in.	144.6	143.5
Steam after super-heater	" " " "	143.0	142.0
Loss through super-heater	" " " "	1.6	1.5
Steam in turbine steam chest	" " " "	91.7	116.0
Exhaust steam from turbine	" " " "	0.0	0.0
Atmosphere	" " " "	14.45	14.5
Drafts.			
Before super-heater	Ins. Water	1.45	1.26
Before boiler	" "	1.81	1.70
In transfer flue	" "	2.65	2.52
Before fan	" "	3.51	3.28

In fan discharge	" "	0.96	.81
Drop in draft from super-heater to fan	" "	2.06	2.02
Drop in draft through super-heater	" "	0.36	0.44
Drop in draft through 1st pass	" "	0.84	0.82
Drop in draft through 2nd pass	" "	0.86	0.76
Drop in draft through boiler	" "	2.55	2.47
Total draft across fan	" "	1.70	1.58
Temperatures.			
Waste gas from super-heater	Deg. F.	1451.2	1372.6
Waste gas after super-heater and before boiler	" "	1269.4	1205.7
Waste gas in transfer flue	" "	793.2	723.4
Waste gas before fan	" "	556.2	525.0
Feed water	" "	177.7	181.0
Steam leaving boiler	" "	363.	362.
Steam leaving super-heater	" "	507.	472.
Super-heat.			
Due to boiler	Deg. F.	0	0
Due to super-heater	" "	145	110
Total Super-heat	" "	145	110
Calorimeter.			
Temperature of steam	Deg. F.	296.65	314.6
Pressure of steam	Ins. Hg.	4.42	4.81
Quality of steam	Per Cent.	99.5	100.

	June 14, '18.		July 1, '18.	
Water.	Bo. Only.	Bo. & Suphtr.	Bo. Only.	Bo. & Suphtr.
Total fed to boiler	129,685	129,685	100,990	100.990
Factor of evaporation	1.081	1.162	1.077	1.134
Equiv. Evap. F. & A.@212°	140,200	150,700	108,600	114,500
Water per Hour.				
Fed to boiler—lbs.	13,086	13,086	12,890	12,890
Equiv. Evap.—lbs.	14,150	15,210	13,885	14,630
Horse power	410	441	403	424
Net Bo. H.P. deducting turbine steam	371.3	402.3	364	385

	June 14, '18.		July 1, '18.	
	Before Suphtr.	Before Fan.	Before Suphtr.	Before Fan.
Gas Analysis.				
CO_2 percent	14.20	12.48	14.5	12.1
O "	5.61	7.17	5.4	7.0
CO "	0.0	0.0	0.0	0.0

Opening of damper to stack (average)	0	0
Steam per hr. to turbine—lbs.	1148	1205
Boiler H.P. of turbine	38.7	39
Turbine speed—R. P. M.	3486	3589
Density of gas at 62° F.—lb.	.07893	.07893

Heat absorbed from gases by steam per hr.—B. T. U.	13,730,000		13,492,000
Heat radiated per hr.—B. T. U.	500,000		500,000
Total heat absorbed—B. T. U.	14,230,000		13,992,000
Total temp. drop across boiler—deg. F.	713.2		680.7
Weight gases per hr. through boiler—lbs.	79,800		82,300
		June 14, '18.	July 1, '18.
Evaporation in 1st pass—percent		67.	70.8
Evaporation in 2nd pass—percent		33.	29.2
Percent drop in temp. between inlet and outlet of available heat		78.7	80.7
Rate of heat transfer, B. T. U. per hour per sq. ft. of heating surface per degree mean temperature difference between gas and steam		5.93	6.31

DISCUSSION OF RESULTS.

The initial temperature of the gas is from 175 to 250 degrees higher than the super-heater specification, yet the temperature of the steam leaving the super-heater is below the guaranteed super-heat. This is partially due to the fact that the capacity of the super-heater is only 12,000 lb. per hour while the test showed 12,890 to 13,086 lb. per hour. The super-heater is set so as to use a hand lance to blow the soot from the outside of the super-heater element.

Comparison of Weight of Gases as Determined from Evaporation with Weight Calculated from Fuel and Charge.

Boiler H.P.	410	
B. T. U. per hour	13,730,000	in steam
	500,000	radiatior
	14,230,000	Total

Temperature range 1269—556=713°.

Weight of gases $\dfrac{14{,}230{,}000}{.25 \times 713} = 79{,}800$ lb.

Tons per heat—78.

Time per heat—9¾ hr.

Pig iron in charge—107,000 lb.

Total charge (assume 88% product)—$\dfrac{78}{.88} = 88.6$ tons $= 197{,}000$ lb.

Percent pig iron in charge $\dfrac{107}{197} = 54\%$.

Kind of coal—Miami (Illinois).

B. T. U. per lb.—10,800.

Lb. coal per ton iron—711.

Lb. coal per hour—$\dfrac{711 \times 78}{9\text{—}3/4} = 5{,}700$.

CO_2 from test 14.2 before super-heater, probably 14. or less before boiler.

Wt. gas per lb. fuel .12 plus $\left(\dfrac{54}{65} \times .17 \times 12\right) = 13.7$ lb.

Wt. gas per hour $13.7 \times 5{,}700 = 78{,}000$ lb.

YEAR—1920.

	Jan.	Feb.	March	April	May	June
Bo. H.P. (net)	4,420	5,090	5,390	4,900	5,500	5,500
Bo. H.P. (gross)	4,470	5,150	5,450	4,960	5,560	5,560
Tons fuel equivalent	7,952	8,500	9,500	8,131	9,710	8,950

The tons fuel equivalent is based on the performance of a stoker fired boiler house which is connected to the waste heat boiler plant.

Bo. H.P. hours per ton steel per month 62

Lb. coal saved per ton of steel per month 290

TECHNICAL SECTION

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STEEL RAILS

By C. W. Gennet, Jr.

Presented November 18, 1920.

Departing a trifle from the usual style of technical papers, I have selected a text for the evening's subject. It is a quotation entitled, "A Railroad Casualty," and reads as follows:

> "The cars on the railroad a short distance east of Rome, New York, came in contact with a 'snake head' on Saturday morning, which threw several of the passenger cars and the mail car off the track. The crush was tremendous, and the cars were torn to splinters, though happily no lives were lost. Mr. Peter Van Wie was badly bruised, and some others slightly injured."

This, according to Swank's most interesting book, "Iron in All Ages," is an extract from a New York newspaper dated May 30, 1844. It is a far cry from 1844 to 1920 but there is a familiar ring to the seventy-six-year-old clipping, and I am not so sure but that some conditions now are, at least to an extent, mere repetitions on a different scale of the trials of long ago.

The casualty mentioned very likely occurred on the Mohawk & Hudson Railroad, a line extending from New York to Buffalo, opened for through traffic in 1842. It was no doubt laid with the old fashioned wrought iron strap rail of rectangular section, perhaps 2½"x9-16", presumably held flat on the stringers, or occasional cross ties, by countersunk spikes. Continued traffic (and possibly heavy wheel loads) introduced strains of compression in the running surface of the rails, so that there was a constant danger of the end spikes drawing and of the rails curling up into a concave position. This very dangerous condition was called a "snake head." While modern practice has eliminated "snake heads" as a menace to safe travel, their fundamental cause was the same as that now ascribed by some as being chiefly responsible for the origin of transverse fissures—the most serious defect to which present-day rails are subject.

Rail conditions in the United States early in 1844 were not pleasing to the railroad officials. There were nearly 4,200 miles of railroad track being operated and the outstanding cause for the officers' complaints was that not a ton of heavy iron rails of any other pattern than the ordinary strap rail had ever been made in the United States. This condition required the importation of practically all heavy rails commonly of the "H," the "P," and the "T" section, or the continued use of the small unsatisfactory strap rail mentioned. "Iron In All Ages" contains a copy of a letter written at this time by the President of the Philadelphia

& Reading Railroad, lamenting on the difficulty of obtaining satisfactory rails from American makers, and which constitutes apparently the earliest record of correspondence on a subject which has since become voluminous in the extreme. After Congress imposed a duty on rails things brightened and a mill at Mount Savage, Maryland, long since abandoned, started rolling "U" rails in April of 1844, though it was not until 1845 that the first "T" rail ever made in America was rolled at Danville, Pennsylvania, and not until twenty years later was the first Bessemer steel rail rolled at the North Chicago Mill.

Thus, the difficulties of obtaining rails in the early days were not so very different from those encountered in recent months, and the question can reasonably be asked as to what is the relation between the demand and the supply of rails today. Some time ago I estimated that there was a shortage of 10,000,000 tons of rails in the United States as of January 1st, 1917. This figure was reached by taking account of the annual consumption of rails for twenty-four years and the increased mileage of the roads reporting to the Interstate Commerce Commission for the same period. The shortage mentioned could be defined as the amount of rail of 85-lb. section necessary to put the roads in a prime physical condition typical of good practice necessary for handling the heavy equipment and traffic desired. No particular reason has developed for modifying the calculated shortage of 10,000,000 tons then existing, but the three years of Government control requires that an addition of probably two million tons be made to it, so that 12,000,000 tons really represents the actual shortage today.

This large deficiency may seem unreasonable but a moment's reflection, and the fact that it implies bringing the roads to a prime condition, will perhaps show its consistency. In this connection, it is surprising to note the large amount of light section rails existing on important lines, where motive power and rolling stock are not only constantly increasing in weight, but where traffic is becoming much heavier. For example, on ten important railroads, namely the New Haven, Seaboard, Louisville & Nashville, Santa Fe, Rock Island, Missouri Pacific, Great Northern, Union Pacific, Northern Pacific, Southern Pacific, there was approximately 32,500 miles of rail weighing less than 80 lbs. per yard at the beginning of 1917. No doubt, a large part of this was laid on other than main line track, the figures for such instances not being available, but four of the roads mentioned are reported as having over 10,000 miles of this light rail in places where its removal appears an early essential .Replacing this 32,500 miles with 85-lb. rail would require over 4,000,000 tons of new steel, or thirty per cent of the country's calculated shortage—and apparently even then only a few of the high spots have been touched.

The shortage can be estimated in another way, with reference principally to the general upkeep of the roads since 1914, when the great war started. For six years prior to 1914 the total consumption—meaning production plus imports and minus exports—of all rails in the United States was 16,085,000 tons, or an average per year of 2,680,000 tons. For the six years 1914 to 1919 inclusive the total consumption was 12,124,000 tons, or an average of 2,020,000 tons. Thus, the total deficiency in consumption for six years is approximately 4,000,000 tons, to which must be added probably a million tons more for the year now ending. In other words, 5,000,000 tons of rail should be provided at once to balance the rate of consumption that existed for six years prior to the war, and, needless to say, this figure takes no account of the tremendously increased volume of traffic which has worn out rails with great rapidity in the last few years.

Calculations, therefore, indicate that as an emergency measure 5,000,000

tons should be immediately furnished the roads, while in addition there is an apparent shortage of 7,000,000 tons more necessary to put the roads in the proper physical condition. These tonnages, representing deficiencies, must be supplied over and above the normal consumption which for a considerable period prior to the war averaged about 2,800,000 tons annually. A very conservative estimate then shows, after making allowance for rates of renewal which cannot be accurately calculated, and allowing 500,000 tons per year for export purposes, that the country's rail mills should be called on to produce at least 4,500,000 tons of rails per year for the next five years to insure a return to normalcy. I fear that the chances of obtaining this enormous tonnage of rails are not bright and not so very different from some of the conditions existing seventy-six years ago.

For many years, up to say 1906, the country's production of steel ingots and rails increased proportionately, rails then being regarded as one of the principal, if not the chief, tonnage factors of ingot production. As high as 30 per cent of the total ingot supply had been rolled into rails, and in 1906, the banner year of rail production, when 3,977,000 tons was rolled, about 18 per cent of all ingots produced were made into rails. Ingot production has steadily and rapidly increased, and in 1917, it was practically double that of 1906. But rail production has almost as steadily and rapidly declined, and in 1917, when all ingot production records were broken, the tonnage of rails rolled amounted to only 6½ per cent of the tonnage of ingots cast. In short, doubling the country's ingot production has apparently resulted in decreasing the rail capacity rather than in adding to it. This, of course, is due to the greatly increased demand for steel products of all descriptions. In the last few years there has been a much larger tonnage of rods rolled for wire drawing than there has of rails, while at the same time the production of sheared plates has passed that of rails, and steel for pipe purposes is about equal to the production of rails. The demand for these miscellaneous products and the lessened demand for rails has resulted in some cases of forcing rails into the background to such an extent that it is doubtful that the rail mills of the country today have the actual capacity that they had ten or fifteen years ago. It must not be supposed that any rail mills have been really abandoned. The point is that the demand for other products than rails has become so great that manufacturers have increased their ingot capacity to take care of it, and in some cases found a way to take care of it by utilizing the existing rail mills to roll those products in. But the balance of a few years ago has frequently been lost. At Ensley, for example, the construction of large plate and structural mills has diverted a considerable tonnage of their steel to those mills, thus leaving the rail mill idle a large share of the time. South Works, for many years a leading producer of rails, has been practically converted to other purposes, and while rails could still be made there easily is abundant quantities, it would be at the expense of making rods or pipe steel, for both of which products there is a crying need. The fact remains that rails cannot be rolled today in the proportion of other days without sacrificing an amount of steel perhaps badly needed in other work.

It is very difficult to estimate the country's capacity for producing rails today, because of these confused conditions. Probably with sufficient insistence the 1906 record of nearly 4,000,000 tons could be reached, but, as pointed out, this could only be done by decreasing production of some other products not now easily contemplated. A conservative estimate of the country's ability to furnish rails without serious interference with other business gives 3,500,000 tons as the possible annual yield, and this is a million tons short of what ought to be sup-

plied annually for the next five years. Let us hope, however, that conditions wi brighten so that, as was formerly the case, the steel rail business will be considere more attractive to the mills and production be resumed on a scale necessary t meet every demand that the roads may make for tonnage and prompt deliver Orders for 1921 rails are running fully twenty per cent larger than the orde placed by the same roads for 1920 rail, a condition which obviously indicates th railroad officials are thoroughly awake to the necessity for rehabilitating the trac as rapidly as time and finance will permit.

"Snake heads" have been eliminated as a menace to rails but other defec have taken their place and serve to foster seemingly continuous discussion aimi toward their avoidance, which necessarily involves specifications and manufa ture of open hearth steel for the common rail sections. Defects are mention especially, because it certainly does not appear at the present time that the we of open hearth rails is open to serious complaint. No doubt rails wear rapidly various places of heavy traffic and have to be quickly replaced but, on the whol there is little question but that the general adoption of open hearth steel has go a long way toward satisfactorily solving problems of wear that were so frequent raised with Bessemer rails. The question of safe rails is now much more impo tant than whether rails will give a year or two more service.

Ordinary figures for failures are not particularly impressive except to t technician. But interpretating published records in a certain way indicates th for open hearth steel one rail out of every 800 laid may be expected to fail a have to be replaced in the first five years of service. Although such figures m seem appalling, solace is found in the fact that only about half of the total fai ures are what may be termed of a dangerous type. The others mostly consist defects occurring in the head of rails, which as a rule can be easily detected careful surveillance and removed prior to the development of further troubl Notwithstanding what the types of failures may be, or how prolific they may b questions of specifications and manufacture are important and deserving of t fullest thought.

There is little use in threshing over the subject of specifications, except in very general way. The matter is in the competent hands on the one side, of t American Railway Engineering Association's Rail Committee, while on the oth side is the manufacturers'. The regrettable fact seems to be that the two sid can not compose their differences as by arbitration for example, and enable single specification to be promulgated for general use by all the roads. My crit cism of most rail specifications is that they are too broad in certain features an too narrow in certain others, with the result that both manufacturers and co sumers suffer aggravating incidents that could easily be prevented. Manufa turers frequently find it difficult to get good steel quickly accepted, and on t contrary, railroads are frequently bound to accept what unquestionably ought be rejected outright.

To illustrate the point, consider for a moment 90-lb. rails for which the are at least four specifications in common use having their low limits of carbo varying by the small difference of four points. If a mill rolling for one custom whose low limit of carbon is .63 per cent happens to get a heat showing .62 p cent carbon but satisfactory in all other respects, the slight difference of one poi of carbon in the specification makes it necessary for the rails ,or perhaps the ingot to be diverted from the original to some other customer. That possibly mea allowing the ingots to get cold later to be reheated and rolled—a performan almost bound to result in inferior practice both in the mill and later on t track. The matter of a few points of carbon, and possibly some other element

has repeatedly been proven to be quite insignificant in the long run and easily overshadowed by the kind of treatment accorded the steel in the mill. Determination of what constitutes a reasonable minimum limit for carbon, and insistance on such as a standard, the same as .04 per cent has been fixed for years as a maximum for phosphorus, would be a great step forward in harmonizing specifications without serious detriment to the users.

Again, specifications lack breadth in the customary clause governing straightening. No doubt the specifications used in 1844 read the same as they do now: namely, that "rails *must* be straight in line and surface." The result of this requirement is that rails may be strained beyond their elastic limit in twenty or more places by repeated blows in the cold straightening press, only then to be shipped to a five or six degree curve and readily spiked into place. Modern section rails are exceedingly flexible and, providing they contain no short bends or sharp kinks, it would seem practicable to accept them within certain limits perhaps, without the damaging cold straightening now given to each and every rail. Experimental lots of such rails have given fair service and the subject deserves more attention.

Most rail specifications are too broad with respect to the testing, both chemically and physically. The chemical composition is invariably obtained by analyzing drillings taken from a small test ingot weighing a couple of pounds and cast while the regular ingots are being poured. There is no prescribed size or shape for the test ingots used by the different mills, nor restriction on whether they shall be cast from the first, middle or last part of a heat. In fact, no restrictions prevail of any moment whatsoever, pertaining either to the test ingots per se or to the chemical practice that may be later followed in doing the analytical work. The result is that the actual chemical composition reported by the mills for their steel may vary decidedly as between different mills, so that a 65 carbon heat in Colorado may be quite different from a 65 carbon heat in Alabama or Pennsylvania. It should be said in justice that this subject is being investigated and early action is hoped for.

The physical tests do not, as a rule, go far enough to protect against bad or unsound rails being accepted and laid in the tracks, only to be replaced perhaps after a short service. Testing two or three pieces of rails to represent as many as two hundred made from perhaps fifty ingots, each possessing marked individuality, even though from the same heat, is incompatible with the tests prescribed for many other products on whose use hinges no important question of life. A requirement for oil line pipe is that each and every length, in addition to passing a careful surface inspection on both the inside and the outside, shall withstand a prescribed pressure test. Each piece of cast iron water pipe, whose walls may be an inch thick, must likewise be tested and inspected. And a most odious comparison with the tests on rails is afforded by a recently adopted specification for wrought iron tie plates, which requires a complete tensile test to be made on one out of every thousand plates, a proportion by weight which if applied to rails would mean something like sixteen tensile tests per heat. The proposed abandonment of the drop test, for years recognized as a standard test for brittleness, and the plan of covering this feature by resort to a measurement for ductility obtained under difficult and uncertain conditions, is regrettable. Granting the importance of ductility for rail steel, the imposition of arbitrarily determined limits for it, the matter of measuring it satisfactorily except in the laboratory, and finally the question of accepting or rejecting rails whose ductility varies by a hundredth part of an inch, is to my way of thinking, positively dangerous. Would it not be better to waive the question of the ductility of rails entirely, as it was so long an

unknown thing, and to devote more study to the definition of "interior defects" and such positive methods for detecting them as would permit of rejecting those rails whose test piece fractures show unmistakable signs of segregation?

The manufacture of basic open hearth steel rails of modern sections is a process fraught with many questions of practice very different from that followed in the Bessemer methods of a few years back. The introduction of large furnaces from which a hundred tons of steel is tapped for a single heat, the casting of as many as fifty ingots on a heat, the use of large heavy ingots, and last but not least the fact that modern rail steel is sufficiently high in carbon to be easily susceptible to heat treatment, are features so influencing the general process as to make constant attention necessary to matters that in the old days were scarcely present at all. My observations of manufacturing conditions, resulting from the closest of contact with the Special Inspection of rails at all of the different mills, convinces me that many of these often neglected matters are paramount to other details so frequently brought to the front; as, for instance, a few points of carbon, And in this connection permit me to say that Special Inspection has not only revealed many important incidents that no mill superintendent will condone when his attention is called to them, but it has also afforded opportunity of tracing the history of bad rails in service back to some slighted detail of manufacture no doubt responsible for the failures.

I regard the manufacture and rolling of rail steel as of more importance than that of any other steel product, and conditions emphasize the necessity of making thorough studies of the various features of present day methods. Such studies must frequently be based not only on the manufacture itself but on the story that the rails in service may later tell. Records for many subjects are already in hand and time and work are merely required to afford definite information on questions of great value to both railroads and manufacturers. Literature is very weak on many of the subjects that ought to be investigated and discussed. And among the many questions that can be raised I suggest some of the following, pertinent of modern practice and especially appropriate, therefore, for original research and study:

1. Are rails made of steel by the Continuous Talbot furnace process comparable with those made by the straight open hearth method? In the continuous process the furnace is seldom emptied but a hundred tons or so of steel is tapped every two hours, as against the ten hours of time required to make an equivalent heat in a regular furnace. Is the steel from the rapid working Talbot furnace sufficiently free from oxides and other impurities to afford good, sound rails, and how can such a matter be quickly proven?

2. What effect, if any, on rails has steel made by the Duplex process, wherein highly oxidized metal is added to the open hearth furnace, sometimes very soon before tapping? How can rails rolled from steel containing excessive amounts of impurities be detected?

3. What effect on rails is produced by recarbonizing the steel in the ladle with coal or coke and then adding cold deoxidizers to the ladle? What is the real effect produced by holding a ladle of steel prior to casting the ingots to permit of time for the chemical reactions to settle?

4. What is the effect on rails rolled from ingots cast with running stoppers and sometimes without any control by the ladle operator? How does the size of the nozzle, pouring temperatures, and time required to cast the ingots of a heat influence rails?

5. How soon after casting ingots should they be charged into the soaking pits in order to assure a minimum of piping and segregation? What effects are produced by delays in promptly charging the ingots to the pits, and what is the effect of unduly and rapidly chilling the outside or skin of the ingots?

6. How long a time and under what conditions of gas and air regulation should ingots remain in the soaking pits? What kind of control of the pits is best to insure against overheating or burning the ingots? What is the effect of rolling rails from ingots one side of which has been heated so hot as to show a bright white spot significant of overheating?

7. What effect on rails has different rates of blooming the ingots? In some cases eight by eight inch blooms are made from ingots in nine passes and in other cases in twenty passes. Some mills work rapidly and others slowly; does this produce any difference?

8. What effect on the grain structure or the life of rails is produced by increasing the number of passes, or work given to the steel, when the ingots are rolled into rail? One mill makes a rail from a nineteen inch square ingot in fifteen passes, while another mill makes the same rail from a twenty-four inch square ingot in twenty-nine passes. Has the average rate of reduction per pass any effect on the life of rails?

9. What matters mostly influence the production of rails showing seams on the surface? Some heats are pratcically free from indications of seams, while on other heats rolled at the same time seams are abundant.

Chicago may be termed the steel rail center of the United States. Contracts for close to 500,000 tons of rails are, or ought to be, placed annually by the railroads whose offices are in Chicago. The first steel rail was rolled here, and in 1912 South Works and Gary together made nearly twenty-five per cent of all the rails rolled in the United States. The Western Society of Engineers, the largest and most powerful of any excepting, of course, the four national institutions, has lately offered a prize of inviting size for the best paper on an iron or steel subject; and another prize for a paper of a similar character has been offered by the Institute of Mining Engineers. Where else than in Chicago is the field so fertile for original research work and technical papers on questions dealing with so important a subject as rails and rail steel? May I not express the hope that the members of this society, particularly those employed at the mills, will very soon take advantage of the opportunity so conveniently at hand and give us the benefit of more information and knowledge on a subject which since 1844 has undergone many changes for improvement, but which is still clouded with uncertainties.

DISCUSSION.

Mr. M. H. Wickhorst: We might consider the history of steel rails a little bit. We started with the old iron rail and the trouble with that, as near as I can make out, was that the heads would split and when we used the first steel rail made by the Bessemer Process, that was so superior it was thought the rail problem was solved for all time. But, of course, heavier loads were put on the wheels and the problem became just as big as ever.

Fifteen years ago or so, before the open hearth had really come very much into use, the rail breakages were so great that in extreme instancs as many as twenty per cent of the rails of a lot would have to be renewed in the first year of their life. In fact, the condition became so serious that the railroad executives

took it up in the American Railway Association and the discussion finally resulted in the establishing of a Rail Research Bureau, and that has kept me busy for the last ten years.

Now as to just what has been the situation with regard to the rail failures in this country: The failures of rails made in 1908 amounted to about four hundred rail failures per one hundred track miles for a period of five years' service. The records and statistics of the American Railway Engineering Association stop with a period of five years' service, because that is probably sufficient in most cases to show the merits of the rails made in any given year.

When we come to the failures of the rails rolled in succeeding years, we find there has been a decrease in the rail failures. The last report shows there were failures for rails rolled in 1914 amounting to about seventy-four per hundred track miles for a period of five years' service. Those are the last rails that have been laid long enough to give five years' service records. The same report, if you look at the performance of the rails on a four years' basis and try to predict what the result will be for five years, shows that the rails rolled in 1915 will give about the same service. When we come to the 1916 rails the failure curve is going to take a jump upward, and particularly when we come to the 1917 roll the failures are going to be very high. The poor performance is coincident with the World War, when the difficulties of steel making and of transportation were great. At some of the mills it looked as if they had perhaps lost control of the situation, but, at any rate, we will be able to look back at the rail failure curve and show just when we got into the World War. There has been some tendency to ascribe the poor performance of rails made during this period, to the under maintenance of track which was a condition during the war period, but the 1914 rails, which have so far shown the best record, were likewise in the track during the same period of under maintenance.

Although I don't like to think of what the next three years is going to show in the failure curve, looking beyond that, judging by the performances of certain lots of rail where there has been important traffic, it looks quite feasible to bring the failures down considerably below the best record we have so far. In some cases we have lots of rail in important service where they have shown no failures.

I was interested in looking over the statistics of the last failure report to find that the Carnegie Steel Company, which has its rails in probably the severest service of the country, shows the lowest failures per hundred track miles.

When the statistics were first gotten out, that is at the time we were running at the rate of 400 failures per one hundred track miles, for five years' service, we set up as the goal, fifty failures per hundred track miles. We have approached that figure, and it looks as if it will be possible to make another reduction of 75 or 80 per cent below the best record so far obtained and that is what he hope will be accomplished by the mills and by the railroads in the future.

Now perhaps I ought to say something as to what kind of steel will be required to do that and talk a little on the inspection feature. It looks as if the best steel-making practice will have to be put into effect. It is going to take steel free from non-metallic inclusions,slag inclusions, etc. We have occasionally lots of rails that would go to the bad very quickly; a slag seam or other, nonmetallic inclusions, some foreign material that is not the same as the steel, and it is just one of the starting points for a break.

With the introduction of open hearth steel we have gone up against another type of failure we didn't have in the old Bessemer. A good many split heads used to show in the Bessemer steel, but we have also the transverse fissure. We

find in the head of the rail may contain numerous cracks, not one or two in the rails, but actually millions of them, from one end of the rail to the other. Of course all of these millions of cracks don't result in a break, but it is only a few of them in the rail which will grow and keep on growing and finally form a fissure and break. That type of failure is a very treacherous one to deal with. Until they come to the surface in some way we don't know of their existence inside at all. The rail maintains its section very well and we cannot see them. The old type of failure that we have had, that of the split head, gives warning before their is a failure, and they can be gotten out, but this fissure type of failure, while it is not as frequent as the other type of failure, still is more dangerous. Our information as to the original small interior cracks is meager, but we can say they are probably interior shrinkage checks.

Mr. Gennet: I do not feel that the discussion of my paper should be closed without a word of thanks to those who have contributed to it. Apart from the meeting at which Captain Hunt and Mr. Wickhorst, especially, spoke so interestingly, it is a source of gratification to know that the paper has attracted attention. Since its publication in the technical press I have received several letters bearing on important features of steel making and rail rolling that indicate the wide interest that is attached to these important matters, and it is regrettable that these are largely personal so that I do not feel at liberty to publish them. One letter in particular, from an evident steel maker, contains two maxims that I consider so pertinent that I venture to quote them:

> "First:—Good sound steel that will produce blooms reasonably free from imperfections must be made in the open hearth; it can not be made in the ladle, in the moulds, at the soaking-pits or at the bloomer.
>
> "Second:—After good sound steel, capable of producing blooms reasonably free from imperfections, has been made in the open hearth, all that has been accomplished can be undone either at the ladle, moulds, stripper, soaking-pits or bloomer."

Without question, these two principals are the essence of good practice and the unfortunate thing is that they are lost sight of in many cases because, with steel making on such a large scale ,and under the prevailing conditions of workmen being paid mostly on a tonnage basis, the personal incentive to high quality is mostly lacking. Deviations that occur from these maxims are matters that ought to be investigated, studied and reported on. In that way the effect of bad practice becomes recognized and more pains taken for its avoidance. Thus, I am constrained to repeat the expressed hope that the prizes now available in this Society, and elsewhere, will be an inspiration and appeal for the offering of papers on the subject in question.

STRUCTURAL AND ELECTRICAL FEATURES OF THE NEW WESTERN UNION TELEGRAPH BUILDING, CHICAGO, ILL.

By EUGENE M. FISK.*

Presented February 3rd, 1921.

Before entering upon a discussion of the structural features of the Telegraph Building, it will be of interest to review some of the events which led the Telegraph Company to build instead of renting or buying property. The necessity for moving became evident when a study was made of the old Western Union building on Jackson Boulevard. This study determined that it was neither practical nor economical to remain there, principally because of the great expense which would be involved in altering the building to accommodate a modern telegraph office and the fact that any renovation would not produce an office capable of handling business as efficiently and promptly as was desired. When it was decided to move, it became necessary to choose a location.

LOCATION.

The important features governing the location of a telegraph main office are:

(*a*) Proximity to the principal telegram delivery and pick-up area.

(*b*) Proximity to a center which affords the shortest average pneumatic tube run to branch offices lying within the business area of the city.

(*c*) Proximity to the arteries of travel most convenient for employees going to and from the office.

(*d*) Proximity to the center of wire distribution and trunk cable routes.

(*e*) Availability of a ground plot or building within the zones governed by (*a*), (*b*), (*c*) and (*d*) of such size and shape as to permit of an efficient layout of telegraph equipment. An important consideration is that the nature of the telegraph business makes it desirable for maximum light to reach all working areas.

The locations of the delivery and pick-up center and the pneumatic tube center do not always coincide as it frequently happens that the financial or wholesale centers lie at one side of the larger telegraph zone and are served by branch offices. The center of the principal pick-up and delivery area in Chicago is approximately at the intersection of LaSalle Street and Jackson Boulevard. In considering the branch office pneumatic tube center, when the tubes already exist in the street, it is obvious that a location not far from the old office would prove desirable to avoid extensive underground changes. The location of the Telegraph Building at 427 South LaSalle Street is therefore within a convenient and practical distance of these centers. Even though it is further removed from the tube center than the old office, it is sufficiently near to insure efficient tube service. The maximum, minimum and average tube lengths from the new office are respectively 5,106 ft., 787 ft., and 2,669 ft. The maximum, minimum and average lengths from the old office were 5,136 ft., 817 ft., and 2,675 ft.

In locating the office, consideration was given to a number of different locations: some were in existing buildings, others were undeveloped property. The location finally chosen consisted of a lot with an old ramshackle building on one end and a garage on the other.

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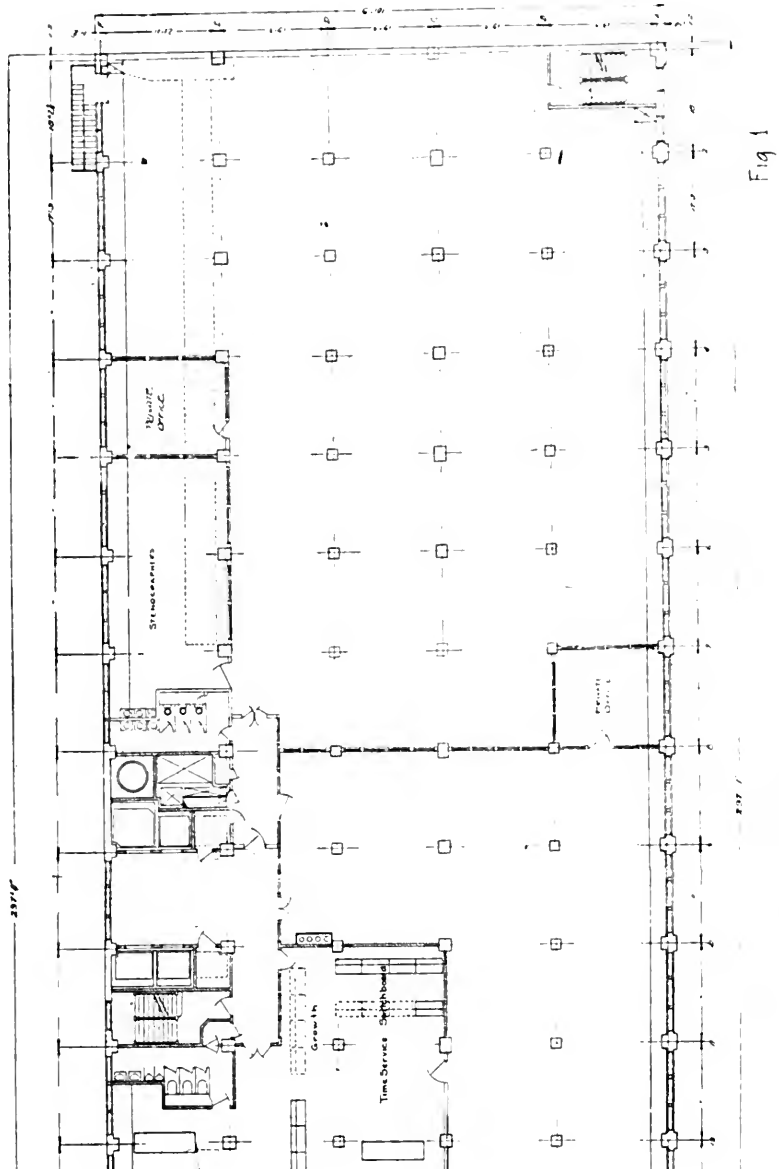

FIG. 1.—Third Floor Plan.

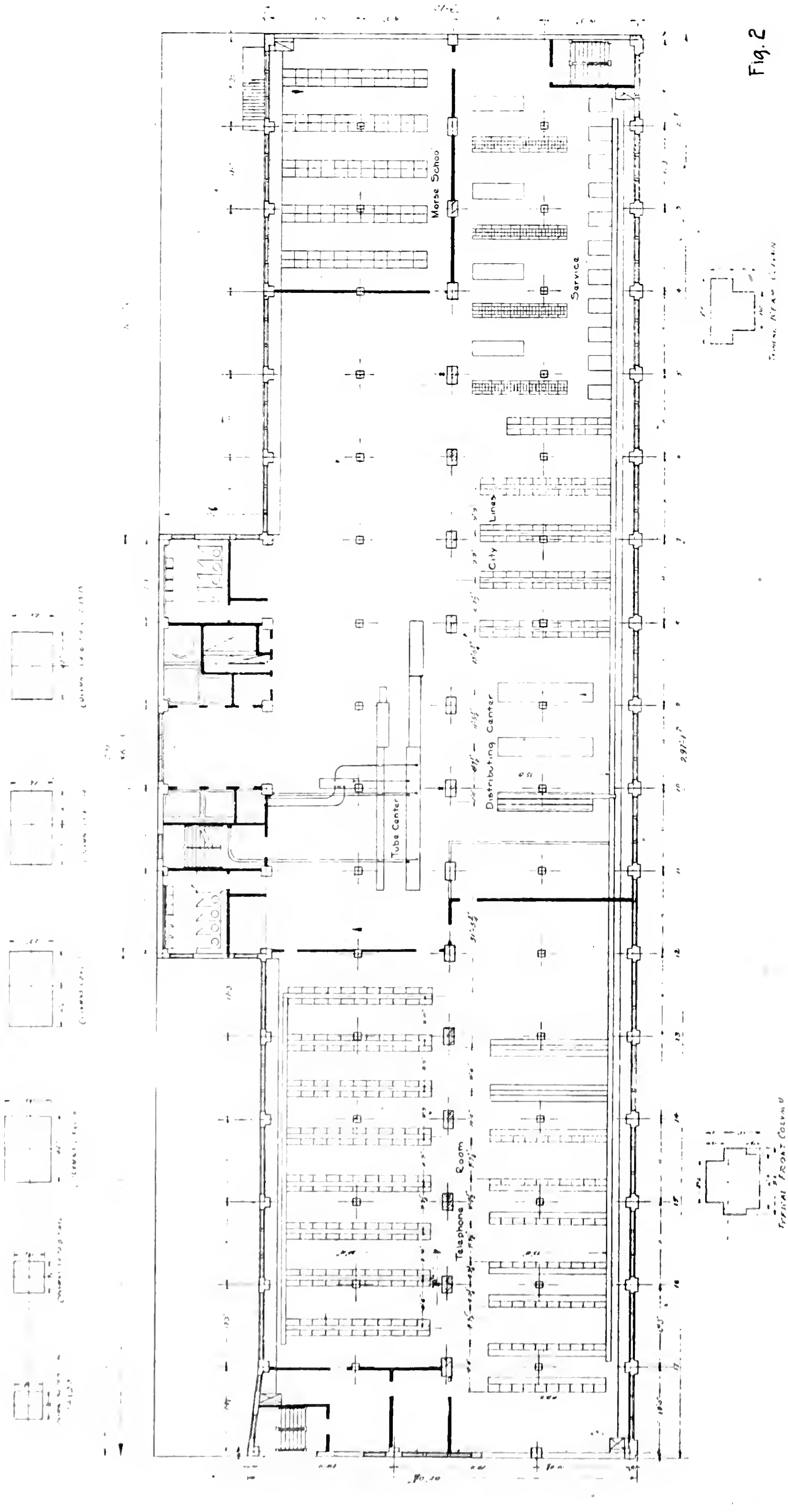

FIG. 2.—Fifth Floor Plan.

The ground plot, which is 300 ft. by 100 ft., is admirably suited for a large telegraph building. The light court of the Fort Dearborn Hotel affords air and moderate light on the north end of the new building. The west front of 300 ft. facing South LaSalle Street is favored with unusual daylight exposure because it faces the train shed of the LaSalle Street Station. Nearly horizontal light therefore penetrates all windows on this front. The opposite or east wall of the building faces a 10 ft. alley. By setting this wall back 20 feet on floors above the third, the effect of a 30 ft. street is obtained, in so far as light and air are concerned.

ARRANGEMENT OF BUILDING.

The building, as at present finished, has seven floors and basement. The foundations and columns are designed to support three additional stories.

As the building is planned exclusively for the Telegraph Company's operating, maintenance and administration departments, and not as a public office building, the first floor level is placed three feet above the street level, making it practical to give moderate daylight and air to the first level basement. This basement covers the entire area of the lot, and extends under the South LaSalle Street sidewalk. It contains 30,600 square feet of floor area, with a ceiling height of 12 feet. The second level basement contains 6,500 square feet, and is used for the accommodation of the building machinery only, such as boilers and pumps. The boiler room and coal bunkers extend through the height of both basements, 28 feet.

The first, second and third floors extend over the full area of the lot, and have 29,200 square feet of floor space. Fig. 1, which is typical of these floors, shows the third floor plan. The fourth to the seventh floors inclusive are recessed at the east side to improve the daylight penetration as already mentioned. The convenient arrangement obtained will be noted by reference to Fig. 2, which is the fifth floor plan. The concentration and centralization of elevators, traffic stairway, lavatories and pipe shaft, leave an uninterrupted working area of ideal shape for operating rooms, and afford a minimum average distance from all parts of the floor to these main avenues of inter-floor travel.

The ceiling heights of the various floors are given below:

First (in clear)	18 ft.	Fourth	13 ft.
First Mezzanine	8 ft. 6 in.	Fifth	13 ft.
Second	12 ft.	Sixth	16 ft.
Third	14 ft.	Seventh	16 ft.

It will be noted from the above that there is a first floor mezzanine. This extends along the entire east side of the first floor, and is 47 feet wide. The advantages offered by this mezzanine are additional floor area at the side of the building where daylight is limited by the narrowness of the adjacent alley; doubling the window desk positions as well as doubling the darker areas away from the windows. The darker areas are advantageously used for filing purposes, and by the use of two floors with low ceilings the necessity for ladders is avoided, with the relatively low filing stacks.

Along its greatest dimension, north to south, the building is divided into seventeen bays, each approximately seventeen feet. There are five bays from east to west, each slightly over nineteen feet, up to and including the third floor. There are four bays on the fourth and fifth floors, and two bays on the sixth and seventh floors, two rows of columns being omitted on the two latter floors, see Fig. 3, leaving only one row of columns down the center of the room. The extremely long bays, nearly thirty-nine fet, unencumbered by columns, permit of an

exceedingly good layout of apparatus and tables for maximum efficiency. The future floors will coincide with the two present upper floors in layout.

The total area of all floors including pent houses is 245,000 square feet. The total cubical contents of the building are 3,407,000 cubic feet.

STRUCTURAL FEATURES.

Construction.—The building is of the fabricated steel frame type with reinforced concrete floor slabs and roof.

The main floor beams are run across the building or from east to west instead of with the length of the building as is often done. The object of so doing is to aid in the proper distribution of daylight; the beams run in the same direction as the light rays from the windows, which are located on the east and west sides of the building.

The extremely heavy beams which of necessity were used on the sixth and seventh floor ceilings, due to the thirty-nine foot spans, do not objectionably increase the ceiling height due to their comparatively large depth; high ceilings in operating rooms are desirable, to aid in the distribution of light and to provide plenty of air space for ventilating purposes.

The columns and foundations were designed for a building which should be ten stories high, although the present structure is but seven stories. A study made previous to the erection of the building determined the height to which it would be most economical to build initially.

The floors are designed for a live load of 75 lbs. per sq. ft., except the basement and a part of the mezzanine; the former is designed for 100 lbs. except two bays at 250 lbs.; the south end of the latter will take a load of 125 lbs. per sq. ft.

There are two kinds of foundations under the building, caissons and piling. Forty-seven columns have caisson foundations; the remainder of the ninety-six foundations are of piling.

The construction of the roof is necessarily semi-temporary as it must be such that it can be easily converted to a floor when an additional story is added. On the concrete slab is a deep cinder fill over which is roofing compound, and a layer of Johns-Manville roofing, the whole being tarred over. There are two handball courts on the roof, screened on sides and top, for the use of employees during rest periods and lunch hours.

Elevators.—Four elevators have been provided for the initial period; there are shafts for two additional elevators which will be installed ultimately. The space allotted for the additional shafts has been floored over at each floor level, thereby providing additional storage and closet space. One of the four elevators is a combination freight and passenger elevator. Its carrying capacity is 4,000 lbs., and it is provided with a 45-horse-power motor. Each of the other three has a carrying capacity of 2,500 lbs. and is driven by a 30-horse-power motor. In addition to these elevators there is a freight elevator between the basement and mezzanine.

Heating and Ventilating.—The heating and ventilating of the building deserve special mention. Practically the entire building is provided with artificial ventilation. The incoming air is washed, conditioned and distributed to various parts of the building. An ample supply of air is provided, making it unnecessary to open windows at any time. This is an important consideration in telegraph offices, as telegrams may be blown out of open windows. Many of the larger offices not having adequate ventilation, are provided with screens to prevent messages from being blown out of windows. The Chicago operating rooms, however, have no screens on the windows. Another important consideration is

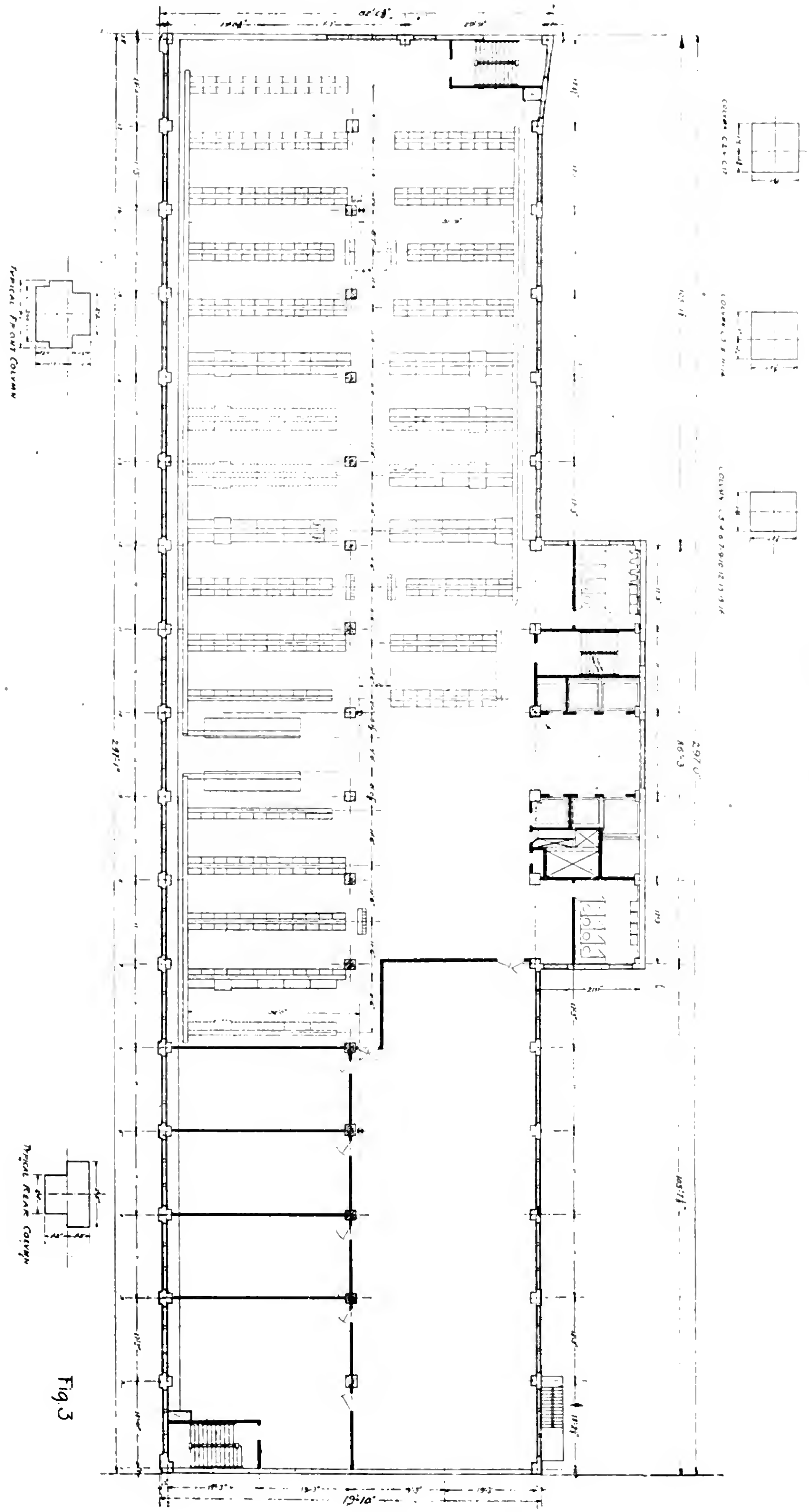

FIG 3.—Sixth Floor Plan.

the humidifying of the air. The relative humidity of air at room temperature should be not less than forty per cent for entirely healthy working conditions. A lower humidity tends to dry the membranes of the nose, throat, etc. In addition, static electricity is developed on the message belt conveyors when the humidity is less than forty per cent. Static electricity on the belts plays havoc with the messages which they carry as the electrified blanks stick to the belts, chutes, frameworks, ceilings, walls, in fact to anything which is in range. Proper humidity avoids these conditions and does away with the manual moistening of the belts. Exhaust ventilation is provided in addition to that described above.

A novel system for distributing the air is provided. By reference to Fig. 3 it will be noted that ventilating ducts follow the east and west walls of the building. Fig. 4 shows a section through one of these ventilators. It extends about two and one-half feet from the wall and is nearly three feet above the floor. Within the enclosure is contained the actual ventilating duct and radiators which

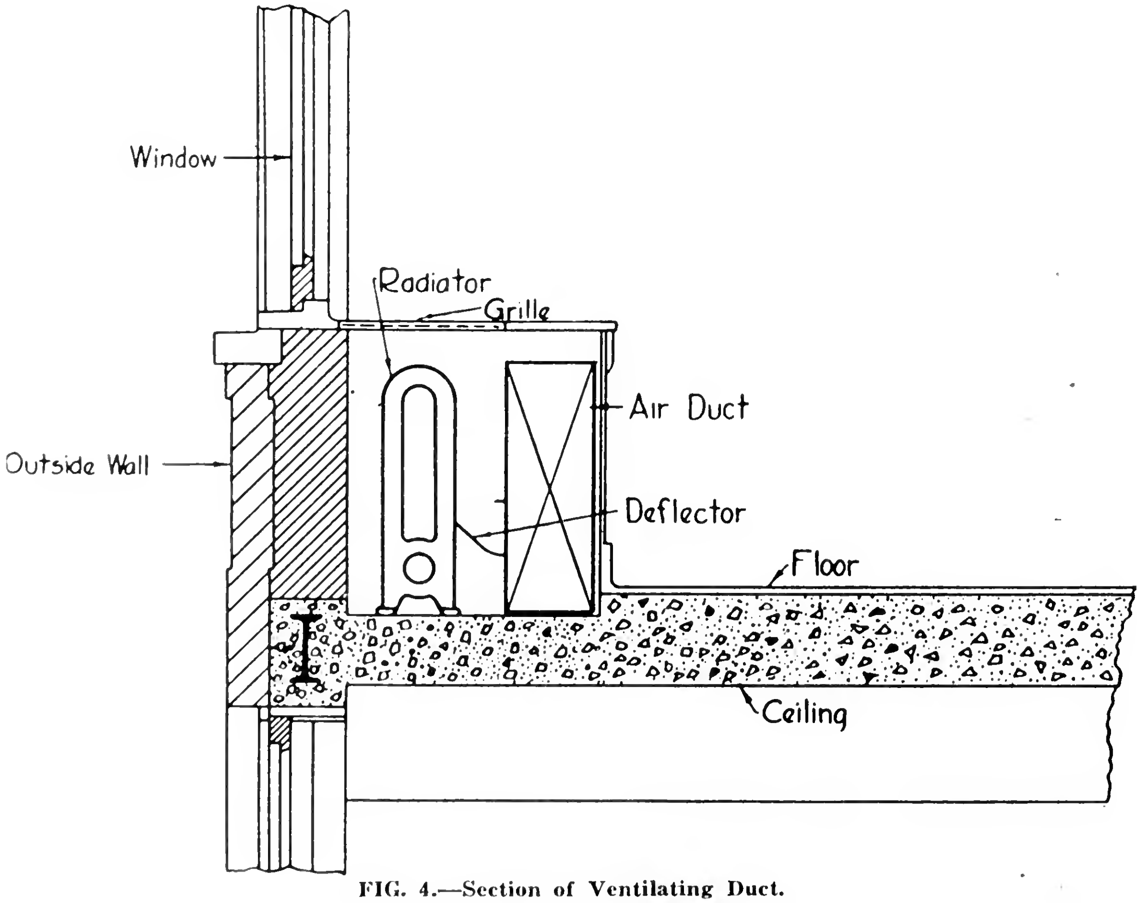

FIG. 4.—Section of Ventilating Duct.

are controlled by thermostats situated on columns located throughout each floor. The entering air is, therefore, not only properly conditioned but also brought to room temperature before entering the room. The enclosure or duct presents a sightly appearance and in addition conceals the radiators.

Fire Protection.—The building has ample fire escapes and stairways. There are three enclosed stairways as will be seen from Fig. 3 and in addition three open fire escapes, only one of which is shown. The enclosed stairways and elevator shafts are provided with *Pyrono* doors. A *Pyrono* door is composed of a core of wood covered on each side by a layer of asbestos upon which is laid a finishing veneer of oak, thus giving the advantages of a wood door. The layers of asbestos

are perforated to avoid the exploding of the door due to gas generated in the core by heat. The *Pyrono* door will stand severe blasts of fire for a considerable period, and affords protection equivalent to any metal fire-prof door.

In the basement is located a Lea-Courtenay Centrifugal Pump which is to be used as a fire pump. It is a four stage pump and is built to deliver 750 gallons per minute at 200 lbs. per sq. inch head and is driven by a 150-horse-power Western Electric motor. This pump delivers water to a riser which has nozzle openings at each floor. There is also a Siamese connection to this riser outside of the building.

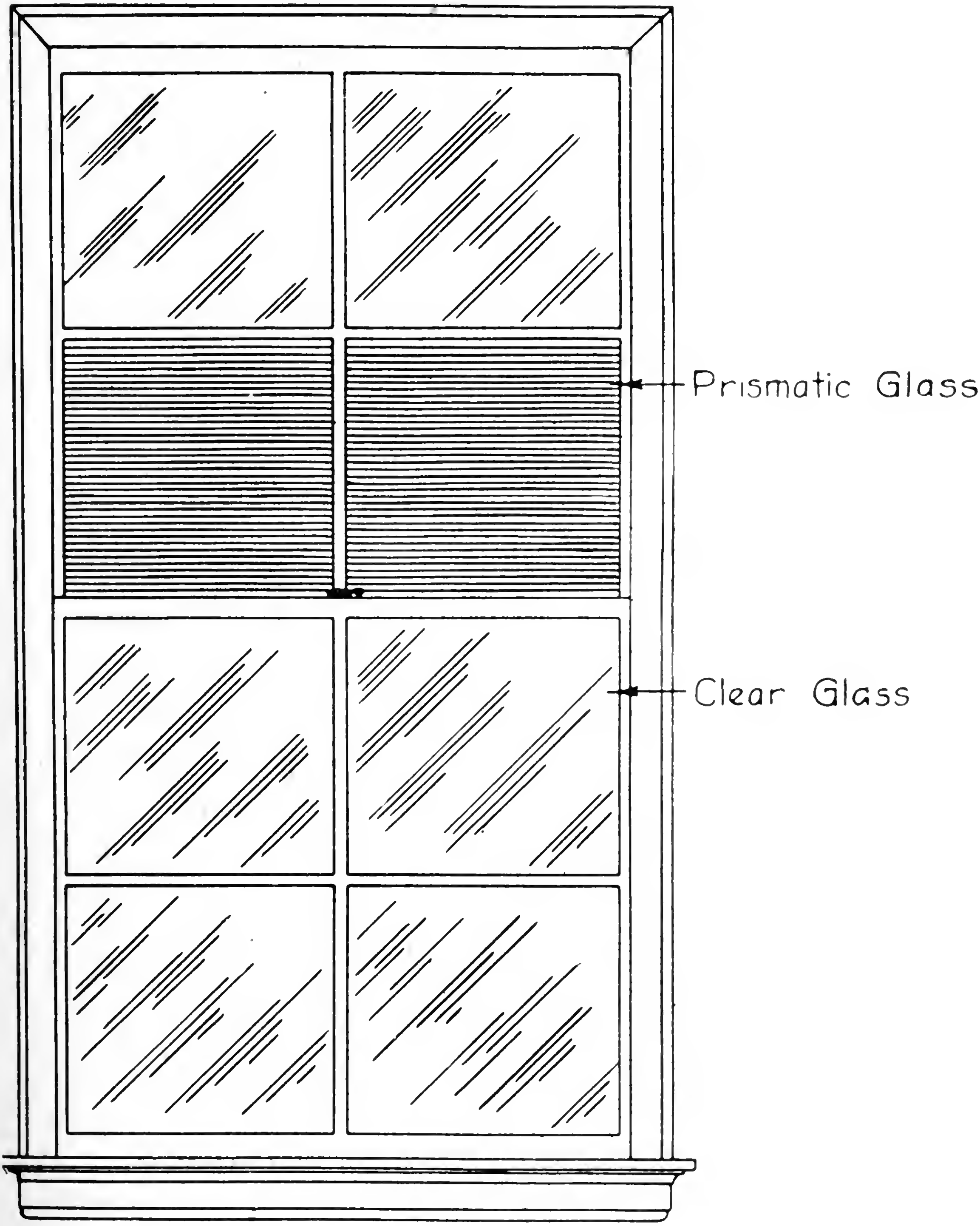

FIG. 5.—Typical Window.

In addition to the above, fire-fighting apparatus such as extinguishers, asbestos blankets, sand pails, etc., is distributed throughout the building. The columns upon which this apparatus is mounted are provided with broad red bands so as to be easily located in an emergency.

A complete A. D. T. fire alarm and night watch box service is installed in the building. There are twenty-nine boxes and eighteen gongs. The latter are so connected that they may be used for fire drills which are conducted at intervals as directed.

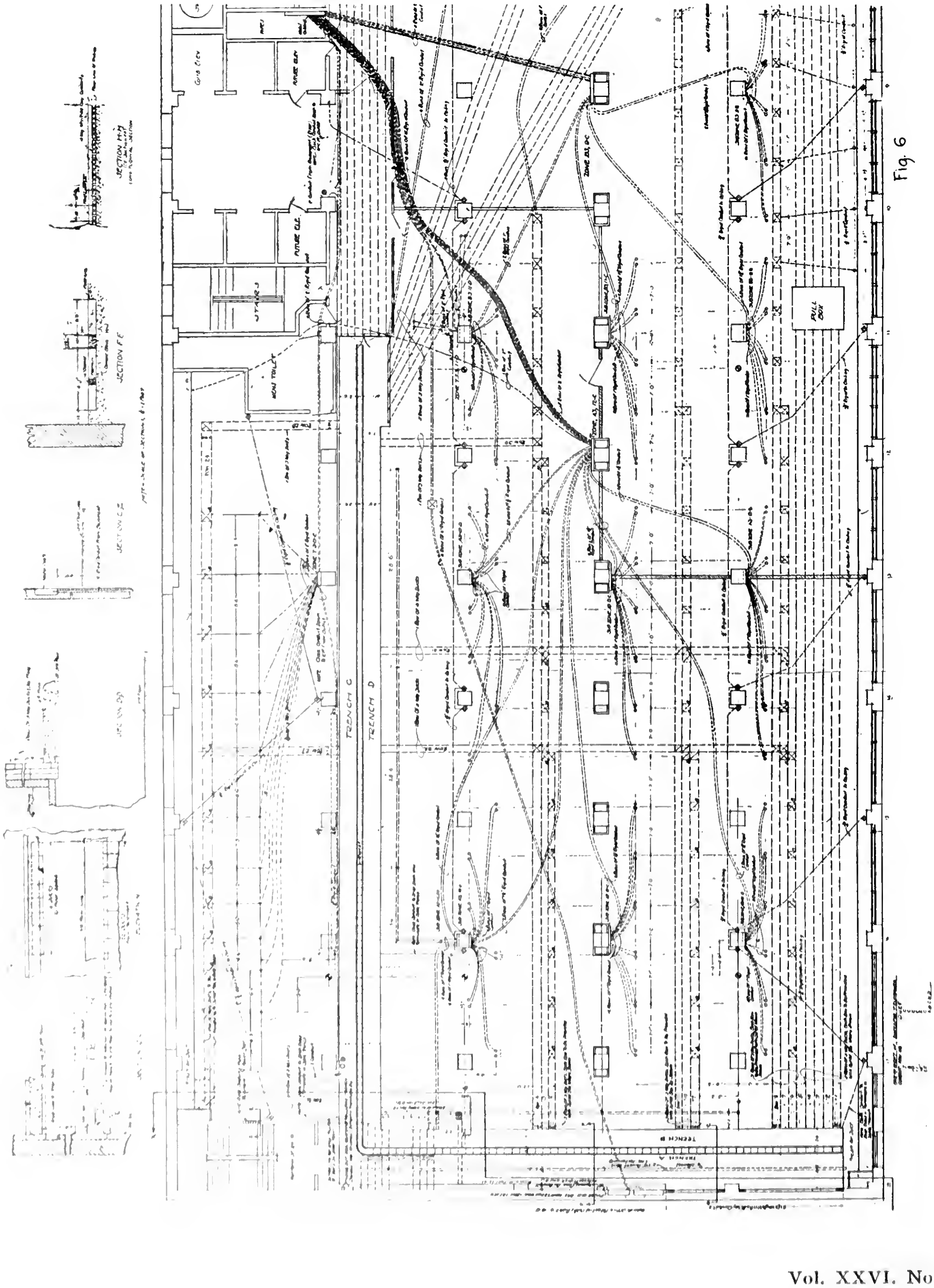

FIG. 6.—Third Floor Conduit Plan.

Glazing.—Especial thought was given to the design of the windows for the building. Fig .5 shows a typical window. Two panes of this window are provided with prismatic glass of the pendent type to throw the light upon the ceiling

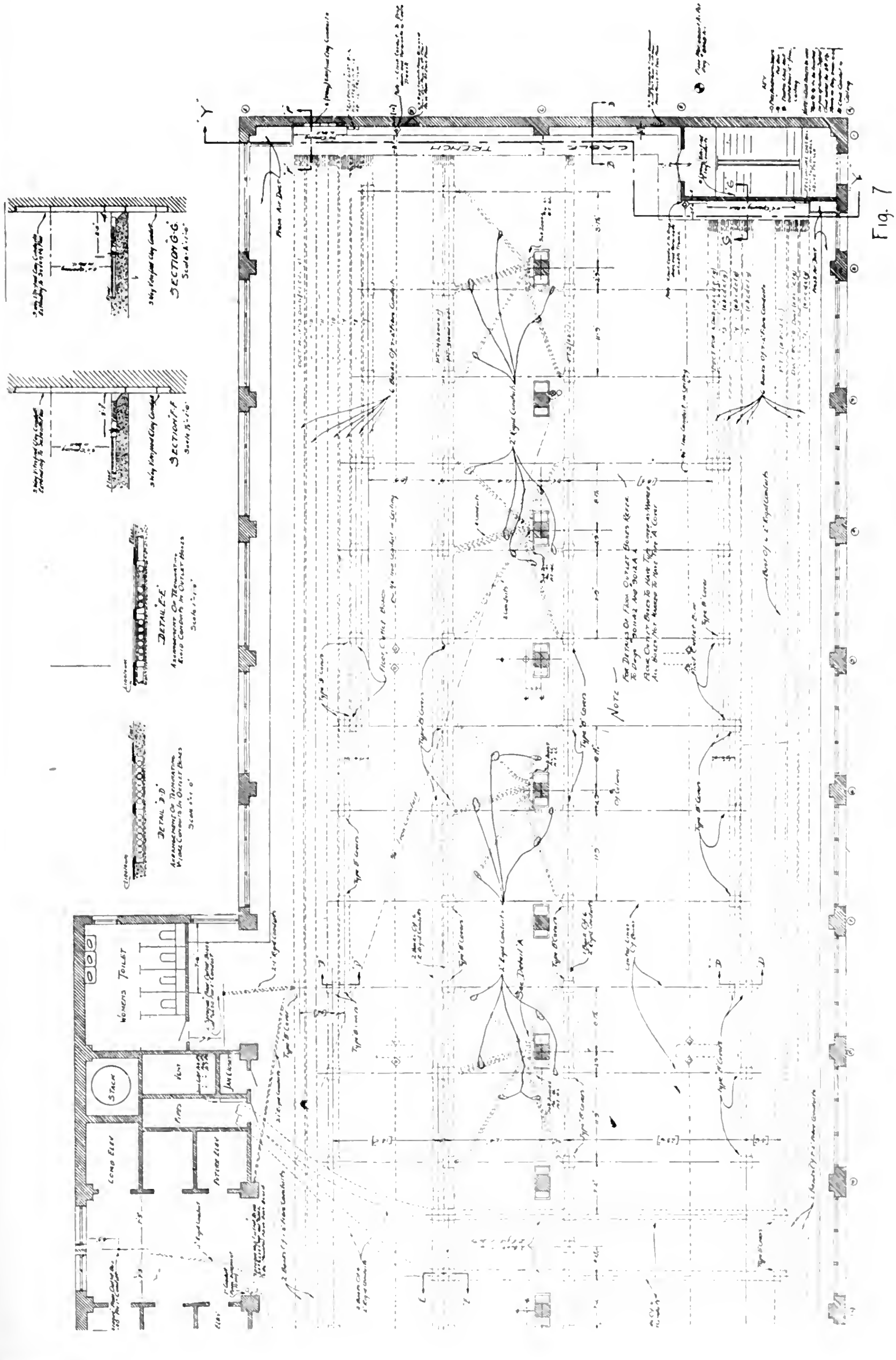

FIG. 7.—Sixth Floor Conduit Plan.

well into the center of the building, thereby giving more uniform light over the large floors.

Employees' Quarters.—Liberal quarters have been provided for the comfort and convenience of the employees. Practically all of the second floor has been given over the locker rooms, toilets and generous rest rooms ,one-half for women employees and the other half for men employees. The men's rest room is furnished with tables and chairs; the women's rest room is furnished with tables, chairs and couches as well as a piano and phonograph.

A large cafeteria, which is open during the entire day, is also provided for the comfort of the employees.

On the first floor the messengers have quite generous quarters. A large space is provided wherein may be checked clothes or lunches. There are liberal dressing rooms, shower baths, a gymnasium, reading room, and a lunch room especially adapted to the needs of the messengers.

Tailor Shop.—A large and up-to-date tailor shop is located on the mezzanine floor. It has electric sewing machines, pressing machines and is strictly modern in all its equipment. Here are stored thousands of messengers' uniforms of all sizes to supply the needs of all offices in the Lake Division.

Conduiting.—In a building erected especially for telegraph purposes, it is necessary to provide a complex system of conduits, floor trenches, etc. Fig. 6 gives an idea of the complicated system on the third floor. Upon this plan will be noted the large trenches placed behind the switch-board and distributing frame. There is an elaborate system of inter-connecting fibre and clay conduits for cables and wires.

The clay conduit system is rather novel as applied to buildings. The ordinary three-way vitrified clay conduit, well known in underground work, has been used underneath the floor. This is probably the first installation in which such an extensive system of clay conduits has been used in this manner.

There is also an elaborate system for power distribution. Connected to the main panel box in the pipe shaft is a bank of conduits which distributes to zone cabinets, these in turn distributing to sub-zone cabinets.

Vertical conduits connect the basement with the third floor, whereon are located the switchboards and distributing frame. The upper or operating room floors are connected to the third floor by a further system of vertical conduits.

Fig. 7, a partial sixth floor conduit plan, shows the conduit system used in an operating room. It is, in general, like the third floor conduiting, but was especially designed to distribute to operating tables and operating table equipment. The seventh floor operating room is provided with an identical conduit system. The power conduits, with their inter-connecting conduits, the zone cabinets, the cable conduits, etc., are shown clearly in the drawing.

For telegraph purposes only, there are 39,600 ft. of iron conduit, 54,600 ft. of fibre conduit and 7,800 ft. of three-way clay conduit used in the building.

Illumination.—The artificial lighting of the building is designed to give an intensity of 4 foot candles in general office spaces and 6.5 foot candles in general office spaces and 6.5 foot candles in the operating room. There is a connected load of 140 k. w.

Building Power Plant.—There are two 300 H. P. Kroeschell water tube boilers which are used for heating purposes. These are provided with La Clede Christy stokers. In the summer the two boilers are not used but instead a small Kewanee boiler is provided to heat the hot water, for building purposes. Except for the boiler feed pump and vacuum pump of the heating plant, all of the building machinery is electrically driven. There are two air compressors which fur-

nish power for the ejector and thermostatic heat control, a circulating pump and a refrigerating machine for cooling the drinking water of the building.

Summary.—The building was designed to be a work building. There is no elaborate or lavish construction, yet everything has been done to make ideal working conditions for employees. Good ventilation, ample light, adequate

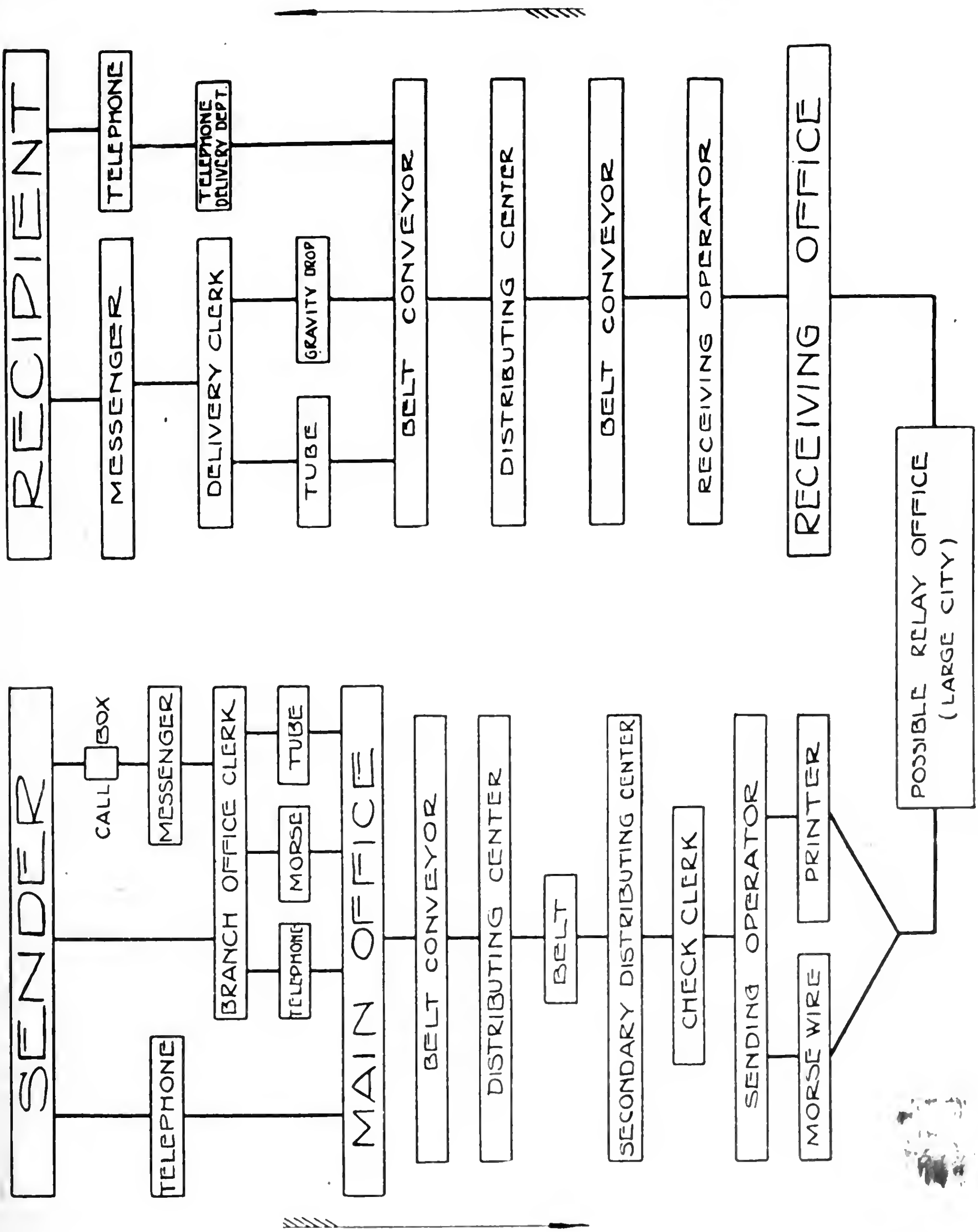

FIG. 8.—Typical Path of Telegram.

employees' quarters and comfortable working spaces have all been provided with this object in view, but above all, the aim has been to make the building the most efficient telegraph office ever designed, capable of handling a larger volume of telegraph business than any other office in the world.

TELEGRAPH PLANT.

The telegraph plant as considered here consists of the power plant, telegraph switchboard, distributing frame, cables, telegraph transmitting and receiving apparatus including printers, belt conveyors, pneumatic tubes, telephone apparatus, time service equipment and ticker equipment.

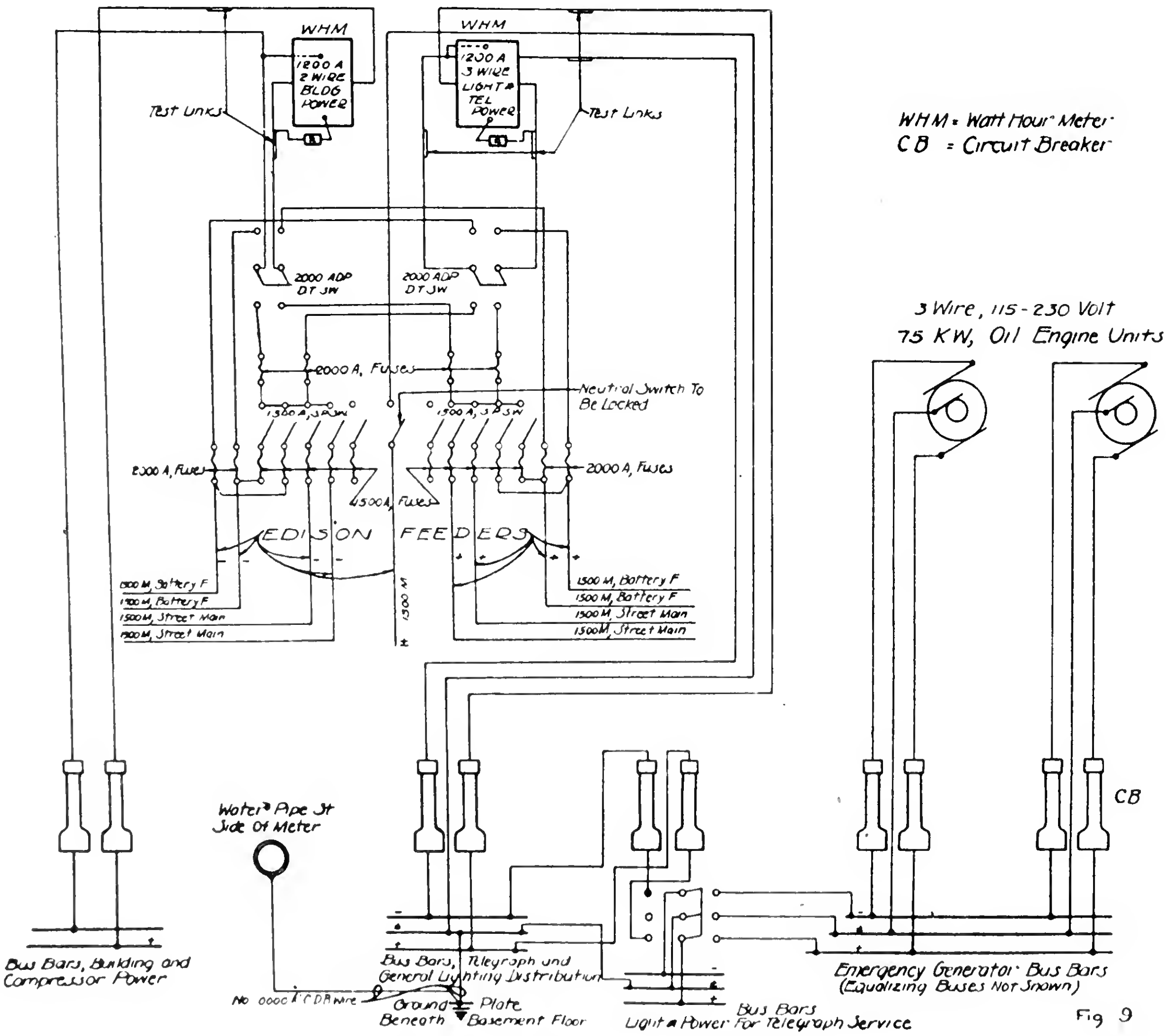

FIG. 9.—Main Power Connections to House Switchboard.

In order that the purposes, which the various types of equipment accomplish, may be fully understood, let us follow a telegraph message from the time it is written by the sender until it is delivered to the recipient. Fig. 8 traces graphically the course of the message beginning with the *sender* and ending with the *recipient;* all of the stages through which it may pass, if handled by a large modern office, are shown. In smaller offices where there are no belt conveyors, messages may be transferred by hand, *kick-back carriers* or *Lamson pick-up systems.* The latter are rare. It will be noted what an important part belt conveyors play in a modern office; they keep the messages moving continuously; there is always a stream of messages moving to and from the distributing center of an operating room. Yet it is but a short time ago when the use of belt conveyors was absolutely unknown in telegraph offices. The modern office could not operate efficiently without them.

Roughly tracing the course of the messages from beginning to end there are not less than ten major operations in the usual routine handling, and if the extra relay office is added a number of extra operations take place.

Power Plant.—The source of energy of the telegraph office is the power plant, and the most important item in this is the motor-generator. In telegraph service many potentials are employed—the motor-generator is used to change the ordinarily obtainable potentials to telegraph potentials. Practically all telegraph circuits employ a return ground for currents flowing. In addition, they employ positive and negative potentials working with this ground, thereby forming a system similar to the Edison three-wire system. Thus, when direct current Edison three-wire power is available, as in Chicago, it is used directly for telegraph purposes. The telegraph potentials employed are 155 volts plus and minus, 160 volts plus and minus, 240 volts plus and minus and 320 volts plus and minus, all working as mentioned above to a neutral wire or ground. Seventeen motor generators, varying in size from 800 watts to 3,500 watts each are employed for generating telegraph power, the total capacity of the machine being 33.1 kilowatts. Some of the older offices have in addition to the potentials mentioned above, 26 volts and 80 volts; these potentials were abandoned after the design of apparatus suitable for use on 110 volts.

Because of the nature of the telegraph business, it is highly important that no interruption to service occur. For this reason reserve power plants or connections are provided in all offices of any importance. Because of its size and extreme importance as a telegraph center every precaution has been taken in Chicago. There are four sets of Edison power feeders of each potential, see Fig. 9; two sets of these feeders are the regular service leads from the Edison Company's power mains; the other two sets are leads from the storage batteries located in the Edison Company's Sherman Street sub-station. One pair of street leads and one pair of battery leads are connected to the Van Buren Street mains, the other street and battery leads are connected to the Harrison Street mains. In case of any serious explosion in one direction or the other, protection exists through the leads in the opposite direction. In case of a general power failure, the storage battery leads can be thrown on to the system separately.

In addition to these special connections to the Edison power supply there is also an extreme reserve power plant consisting of two 75 k. w. 115-230 volt direct current generators direct connected to the two 120-horse-power Semi-Diesel engines. As these units cannot supply the entire current required by the building it has been necessary to separate the light and power required for telegraph service from the rest of the lighting and power load of the building, as will be seen by the connections of the three-pole double-throw switch in Fig. 9, where it will be noted that only certain necessary power may be connected to the reserve units.

The power distribution is shown by Fig. 10. Blocks A and B are the building power and general building lighting. Block C, which is separated from them, may be disconnected from the rest of the plant and run from the reserve. This block contains telegraph power, including time service, and belt conveyors.

Power from Block C is distributed to the various parts of the building by a system of zones. Each floor has its zone cabinet, some floors have several. Certain floors also have sub-zone cabinets from which distribution to various types of apparatus is made.

Telegraph Switchboard.—Under this heading will be described cables, the telegraph switchboard, distributing frame and repeater tables. Before considering any of these in detail, it will be useful to consider the path of a wire which

enters the office. Fig. 11 shows simply the connections of the wire. The incoming cable is terminated on the distributing frame, where it is cross-connected to another cable leading to the switchboard. The wire is then patched, as indicated to a loop leading to a Morse table via the distributing frame. The patch-

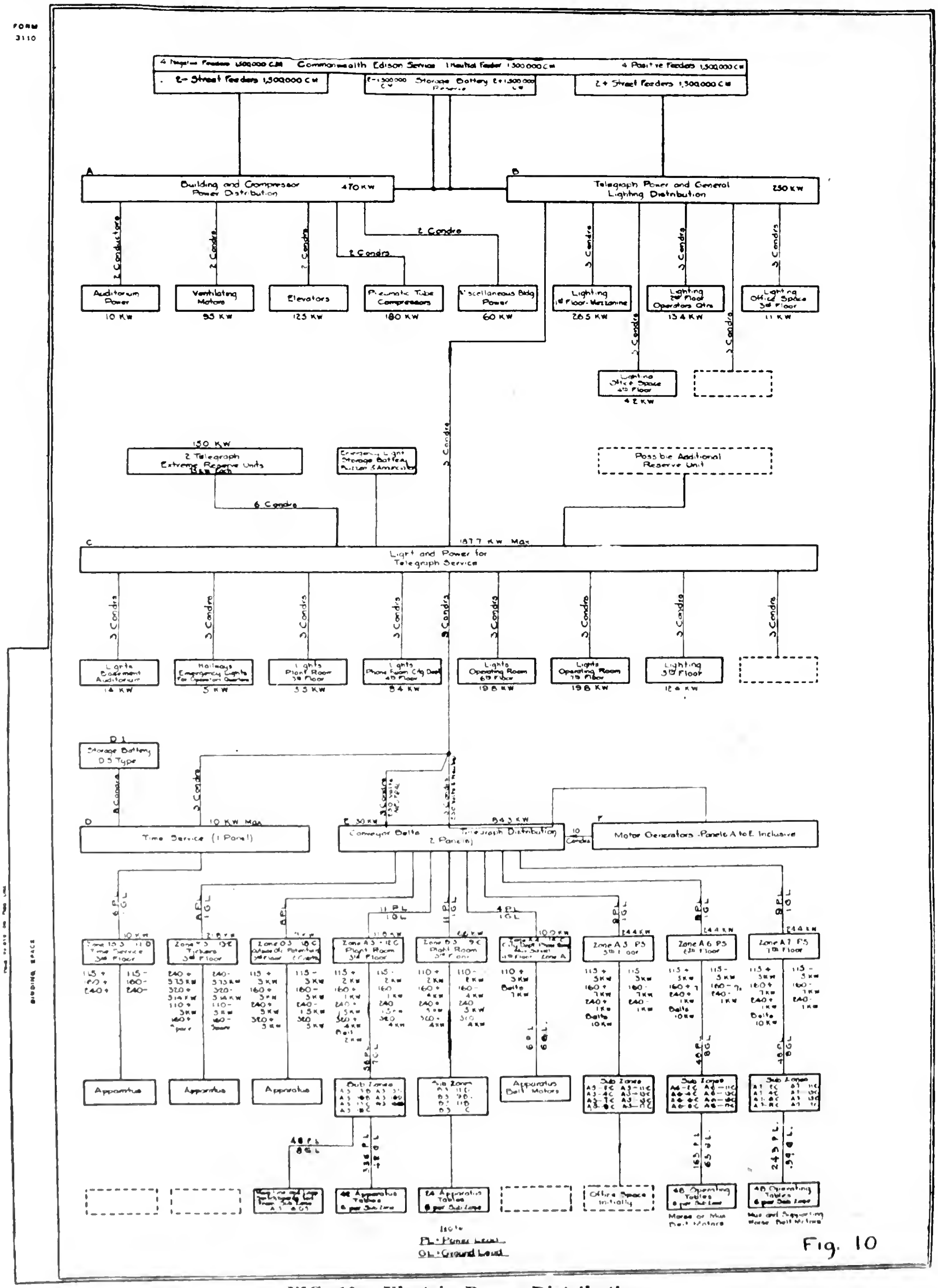

FIG. 10.—Electric Power Distribution.

ing process is such that the wire can be put on any table position. The cross connecting wires on the distributing frame make it a simple matter to change switchboard assignments, i. e., to terminate a wire at any desired point on the board. Fig. 12 shows a part of the Chicago distributing frame.

The connections for a duplex terminal wire are considerably different. Fig. 13 traces the course of a wire which is working duplex, and indicates its associated apparatus. As in the preceding case, the incoming wire is terminated on the distributing frame and cross-connected to the switchboard as shown. It is then connected to a repeater table via the distributing frame and terminates on a terminal duplex set. The locals of this set are extended to the loop board via the distributing frame, and may be patched to a duplex table set or to a branch office loop, as desired. A repeater table is shown in Fig. 14. The apparatus here shown is similar to that which would be used as terminal apparatus for the duplex.

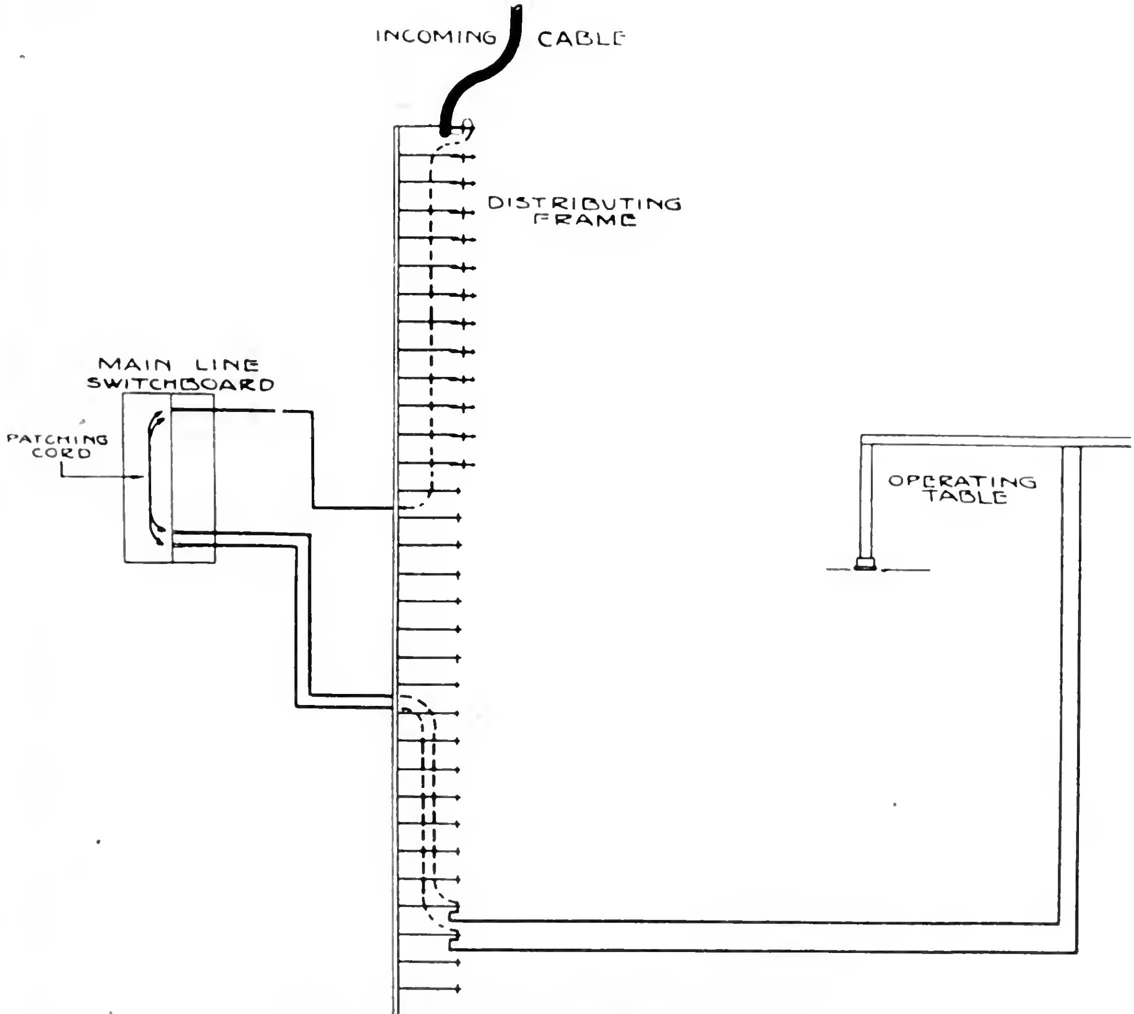

FIG. 11.—Morse Wire, Theoretical Connections.

There are 28 sections of switchboard, a typical view of which is shown in Fig. 15. The jacks, lamp panels, patching cords, testing sets, and volt-mil-ammeters are shown in this view. While all switchboards look much alike there are three types of boards, loop boards of which there are five sections, main line switchboards of which there are twenty sections, and city line switchboards of which there are three sections. The first two have been mentioned above; the latter contain the wires leading to the branch offices around the city.

There are 26 cables entering the building and terminating on the distributing frame. These vary in size from 38 pairs to 257 pairs each, and total 2,214 pairs or 4,428 conductors. There are in addition 315 cables connected to the distributing frame and used for the connections inside of the building to operating and repeater tables and to switchboards. Ample room for growth is provided on the distributing frame.

Cable racks, Fig. 25, serve to carry and distribute the cables along the distributing frame and between this and the switchboards. This view taken at the northeast corner of the room well shows how involved the problem of cable distribution becomes in a large office.

On the repeater tables, Fig. 14, there are 141 duplex sets, 54 quadruplex sets, 19 *universal* duplex repeaters, 21 half repeaters, 28 single line repeaters, 18 duplex half repeaters, 2 *rotary* repeaters and 2 metallic repeaters.

Repeaters have not before been mentioned. They are used to sub-divide long telegraph lines into shorter electrical sections, without interrupting the continuity of the signaling circuit. When the various line constants become such that satisfactory operation is not possible, the placing of a repeater at a central

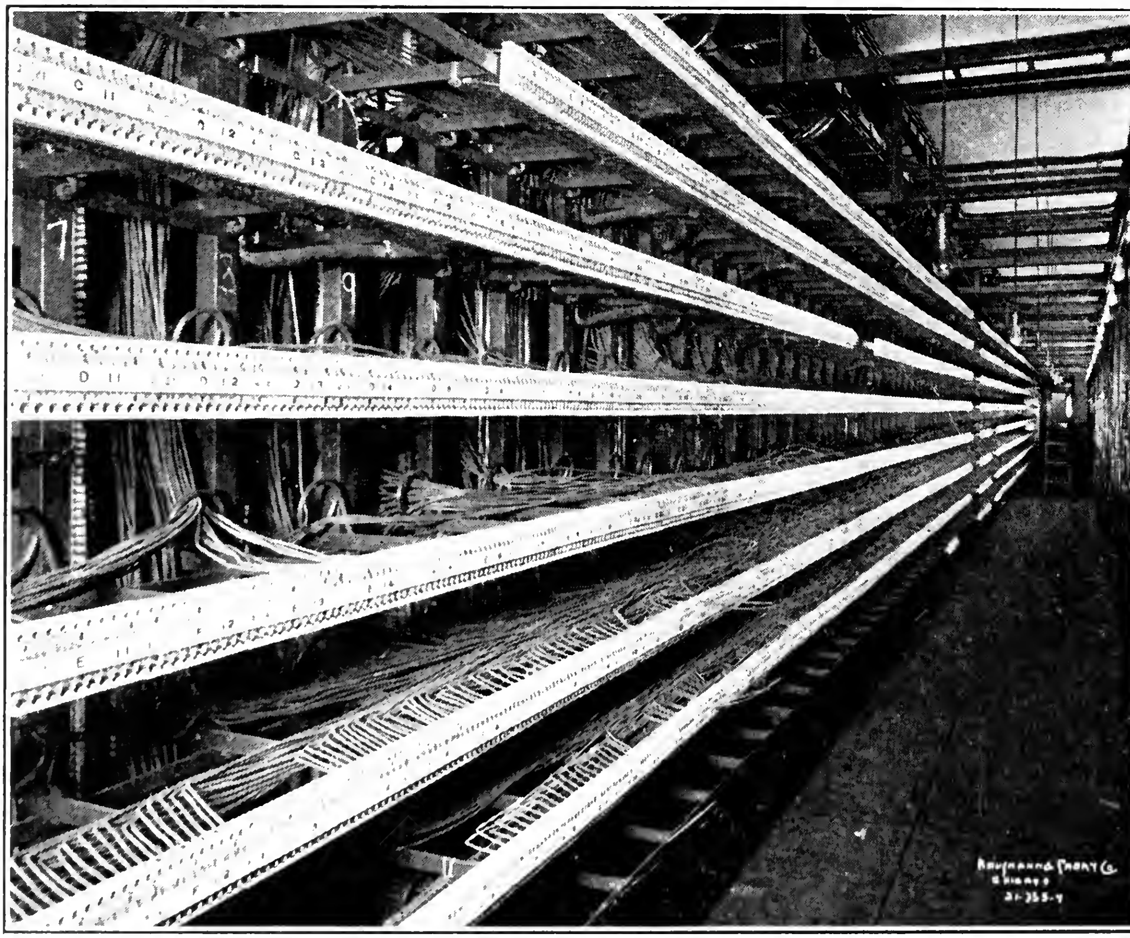

FIG. 12.—Distributing Frame.

point has much the same effect as shortening the line to one-half its actual length, and thereby improves the transmission to that extent. The most generally used repeater for our high speed work is that known as the *Universal Repeater.* A new type of repeater known as the *Rotary Repeater* is used on important multiplex printer circuits: it not only serves to repeat the impulses accurately as is done by the *Universal Repeater,* but actually serves to correct, within limits, imperfect signals received when they are re-transmitted. Metallic repeaters are used on metallic or ungrounded circuits. Metallic circuits are favored as a means for securing transmission totally immune from extraneous disturbances such as the aurora-borealis.

Operating Room.—The sixth floor plan, Fig. 3, shows one of the operating rooms. The characteristic spacing of tables, the wide aisle down the center and the distributing center are typical of a large Western Union telegraph office. Fig. 24 shows a general view of this floor.

The distributing centers of the sixth and seventh floors are located vertically above the fifth floor center to facilitate communication between the floors. They are also at the centers of the floors, thereby accomplishing for messages, a minimum average travel distance between the distributing center and all portions of the operating room.

There are three general types of telegraph positions, simplex or single morse, multiplex including duplex or quadruplex, and printing telegraph. The morse position has a standard width, 33 inches, and in general consists of a key, sounder and relay. The operator may send or receive telegrams on a morse wire. The

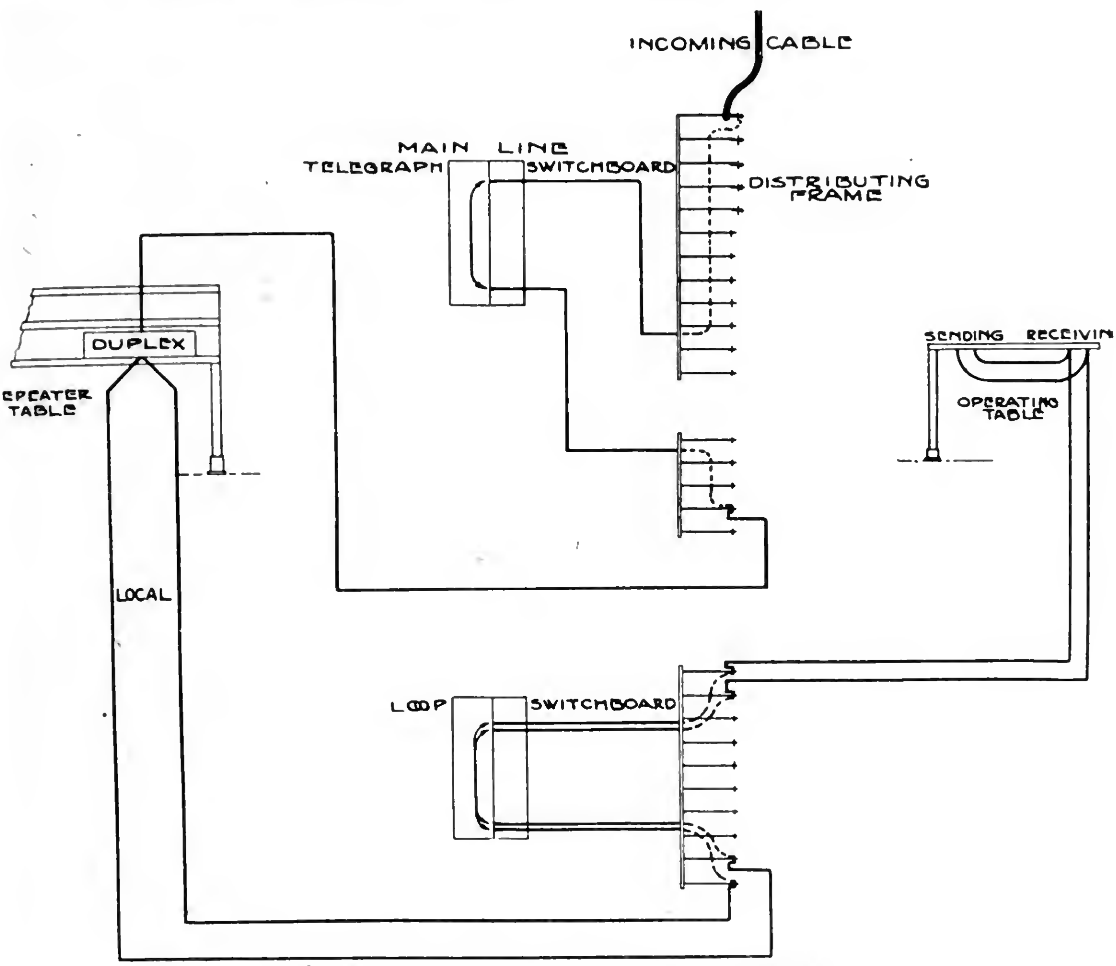

FIG. 13.—Duplex Wire, Theoretical Connections.

duplex and quadruplex positions have only the key and sounder, as the terminal apparatus is located on the repeater tables. There are two standard positions to a duplex, one for sending and one for receiving; the quadruplex has four positions, two for sending and two for receiving. The printer positions are 66 inches wide and have one perforator and transmitting position and one receiving position; a printer position, in the case of a Morkrum printer, is also a complete unit. In the case of the Multiplex Printing Telegraph, which is the standard printer of The Western Union Telegraph Company, this position is known as a channel. In addition to the operating positions, each multiplex circuit is provided with a line unit position or distributor table. This is placed at the end of each set, and

contains the terminal apparatus, which corresponds to the terminal apparatus of duplex sets found on repeater tables. This line unit contains the revolving head or distributor, corrector, driving fork, synchronizing unit, main line and local relays and miscellaneous terminal apparatus.

The multiplex, as it is generally called, may have up to four channels. When working four channels there are eight messages on the wire simultaneously—four being sent and four received. The seventh floor is devoted almost entirely to the multiplex.

FIG. 14.—Repeater Table.

Referring to Fig. 3, at the south end of the floor will be seen a number of lecture and school rooms. In these are contained the instruction schools for our various employees ,including multiplex, morse and telephone operators. The employees are given a course of instruction which is combined with their work and is completed on the Company's time.

In order to save space and to concentrate apparatus, a type of equipment known as a concentration unit is employed on morse circuits, see Fig. 16. At the center of the illustration immediately above the cards are shown two panels equipped with signal lamps and answering jacks. When an office calls, the lamp on its wire lights. This signals an operator who will answer the light. The larger lamp above on the relay rack also lights when any of the individual signals flash. When a call is answered boht lights go out. Some of the positions used in connection with the concentration unit are so connected that by throwing a switch they may be connected to the main line switchboard and given a regular assignment. Above the jack panels will be noticed two message racks. The

outgoing business is filed in these so that operators or supervisors may observe when any messages are to be sent.

There are 538 morse positions, 173 multiplex printer combined sending and receiving positions and six Morkrum printer combined sending and receiving positions on the three operating floors.

Telephone Room.—If a subscriber goes to his telephone and calls "Western Union," he will be connected with the telephone room shown on the north end of the fifth floor, Fig. 2. The answering operator will be at one of the recording boards,, on which there are 40 operators' positions. The message is recorded on a typewriter and placed on a belt conveyor.

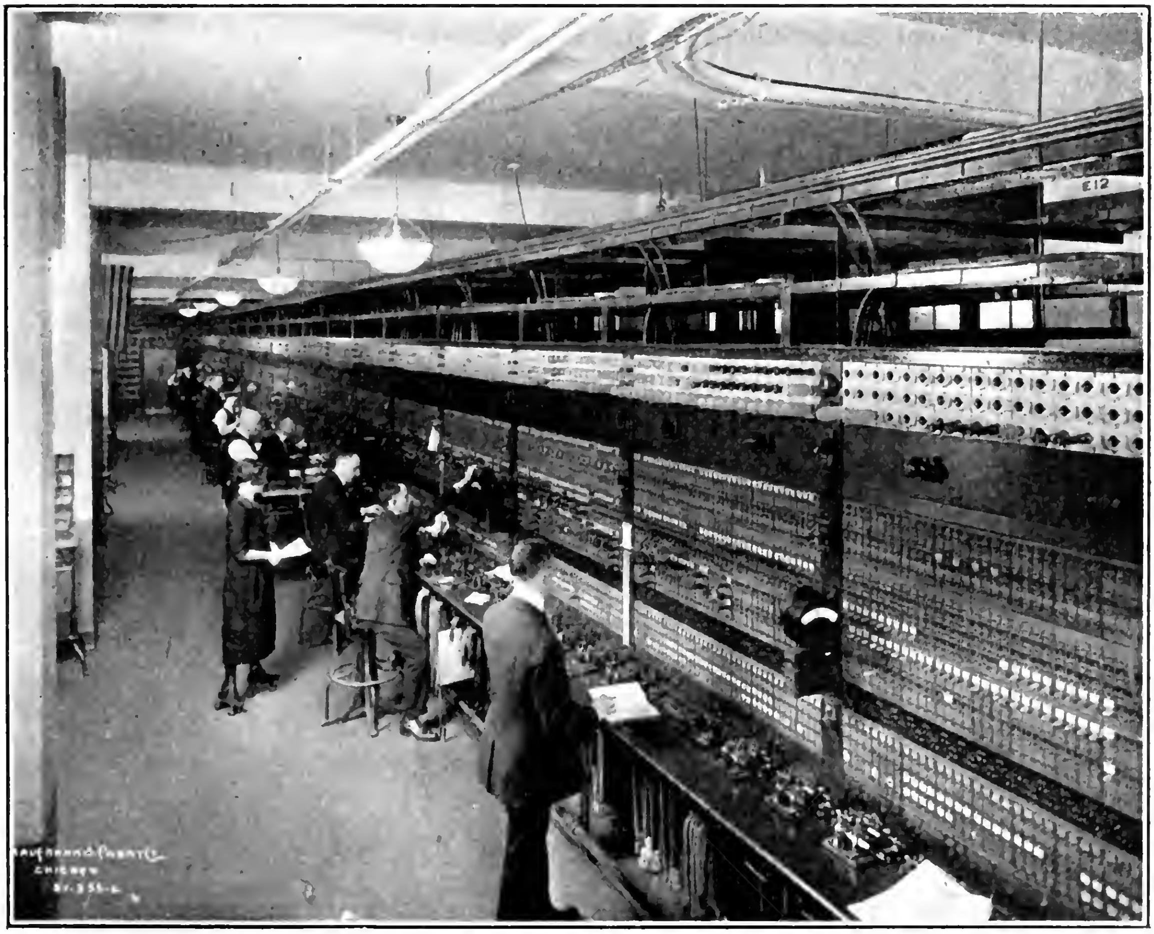

FIG. 15.—Telegraph Switchboard.

There has recently come into use another type of telephone equipment with which the public is less familiar. This is the telephone equipment used to connect the smaller branch offices with the main office. A large amount of business is handled in this way. The concentration unit principle described above is also employed here. The operators sit at standard operating tables which are equipped with telephone apparatus. The same principle is used and applied to "private branch offices" which are simply the offices of large customers who are connected by this means directly with our main office. Messages may be sent or received at these telephone positions. There are 66 positions of branch office telephones.

Another part of the telephone room is the delivery department; messages are telephoned directly to the subscriber from here.

In addition to the above, there is the usual private branch exchange with outside wires from the Chicago Telephone Company's exchange.

The ceiling of the telephone room has been given what is known as acoustical treatment to deaden the sounds caused principally by typewriters, belt conveyors and voices. This treatment most effectually deadens the sound and at the same time does not interfere with the reception of a message by any particular operator. In addition the efficiency of the operators is greatly increased by the reduction of noises.

The acoustical treatment consists of a layer of soft felt applied to the ceiling and covered by muslin to give it a sightly appearance. When sound waves strike the felt instead of reflecting or echoing back they are absorbed. If an open window be considered as a 100% perfect absorber of sound produced inside a room, the felt treatment has an efficiency of approximately 55 per cent.

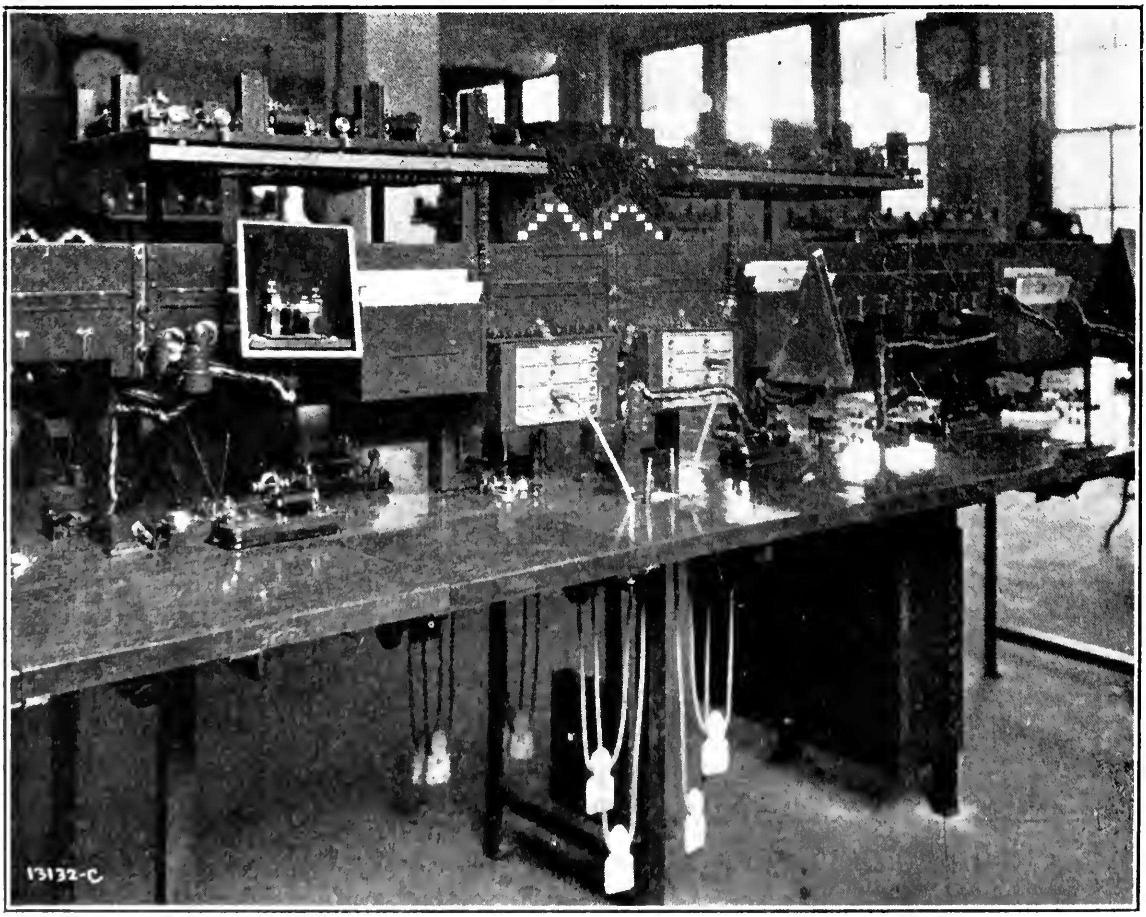

FIG. 16.—Concentration Unit.

Message Conveyors and Distributing Centers.—The two message conveyors used principally by the Western Union are belt conveyors and pneumatic tubes. It is due principally to belt conveyors that the present day distributing center has been made possible.

A message belt conveyor consists of a trough formed by two pieces of bent-up angle iron, supporting an eleven-inch cotton belt which runs on ball bearing rolls. If the belt runs vertically it is known as a riser. An incline belt follows a slope of perhaps twenty degrees. Belt conveyors may be one or two way. In the latter type, the return side of the belt is also used to convey messages.

To understand fully the remarkable advantages offered by the belt conveyor we may refer again to Fig. 8, where it will be noticed that the belt conveyor serves as a connecting link between practically every operation in the complete transmission of the message. When the operator receives a message it is immediately placed upon the belt conveyor in front of him, see Fig. 17, and will continue in motion until finally disposed of. The operating table belt discharges upon a pick-up belt which carries the message to the distributing center, where it is delivered upon a slow-moving belt. The slow-moving belt runs along the top of the table and is within convenient reach of the sorting clerks who are seated at the table. Above the table, see Fig. 18, are perhaps five or six belts, all within reach of the sorting clerks. The sorter will pick up the telegram from the

FIG. 17.—Operating Table.

slow-moving belt and immediately place it upon one of the stack of belts above the table. From there it will be carried rapidly to either another distributing center to be put on a proper belt, or to a sub-center from which it will be taken manually and placed at a sending operator's position to be re-transmitted to its destination. The actual time consumed by a message passing through any one office will not exceed three minutes.

Thus it will be seen that the message never ceases to move from the time it is swiftly carried from the receiving operator or clerk until it reaches the sending operator's position for re-transmission. With other types of message carriers such as *kick-back carriers* or *Lamson pick-up carriers*, where manual removal of messages from receiving operators largely enters into the handling, messages are sent to or received from the distributing center in bunches.

Fig. 19 shows a schematic or theoretical layout of the Chicago belt conveyor system. There are three distributing centers, one on each the fifth, sixth and seventh floors. From each center, messages may be sent to any part of the floor on which it is located, or to the center on some other floor. There are two main tables containing belts in each center. These in turn have inter-connecting belts in case a transfer of telegrams proves necessary. By means of the belts quite a simple form of center becomes possible. Each belt leading from the center runs then to a central point or division of an operating room. A continuous flow of traffic to and from the main center results; a minimum delay is thereby attached to messages.

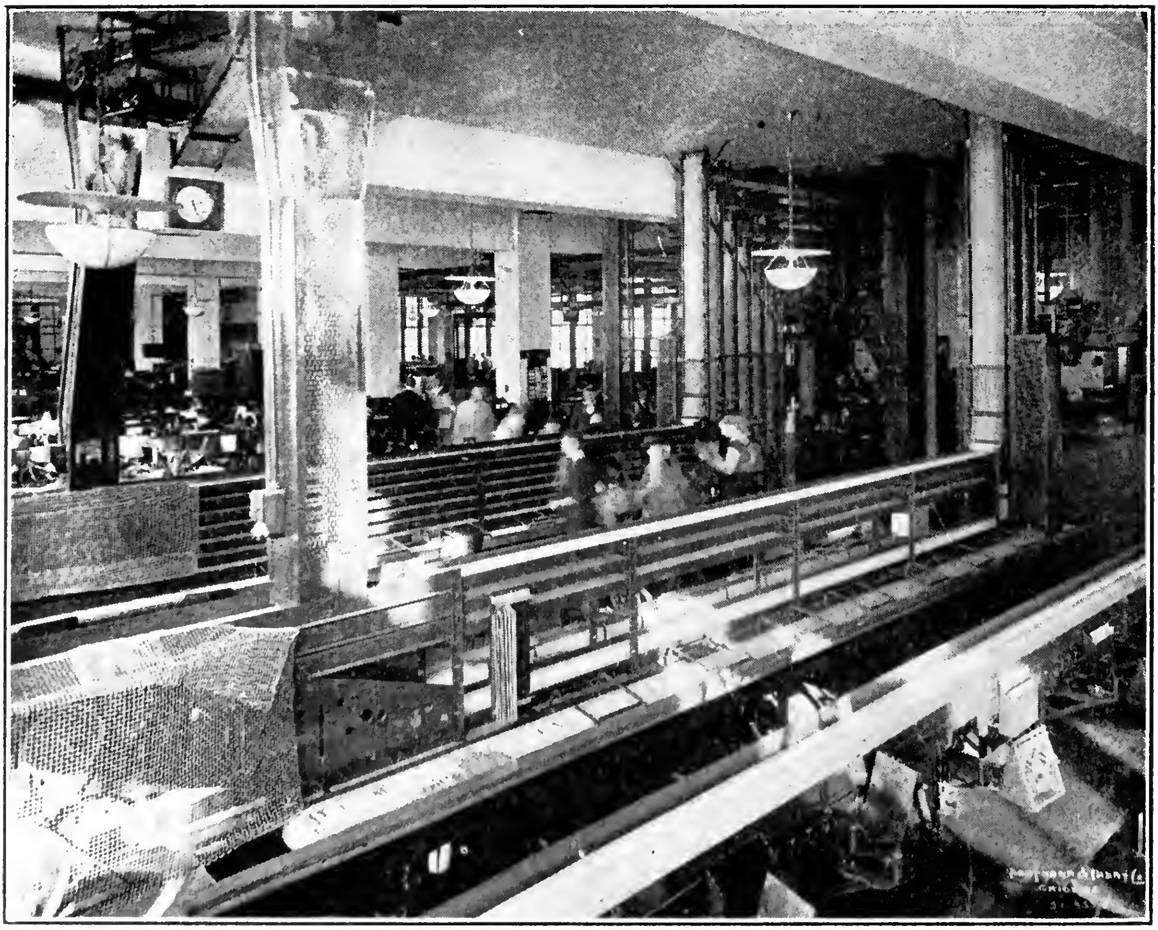

FIG. 18.—Distributing Center.

Many interesting engineering problems presented themselves during the development stages of belt conveyors. Various devices were designed and added to the conveyor equipment, and changes were made in the conveyors themselves until, with the present belt conveyors, faulty operation is rare.

An interesting problem which presented itself in the early stages of development was the static electricity which developed on the belts and which electrified the paper whereon the telegrams were written. Devices to neutralize the electric charges or to remove them from the belts proved unsuccessful. Moistening the belts prevented their electrification, but difficulty was found in keeping them moist. A continuously operating atomizer connected to the city water system would keep a belt too wet for satisfactory operation; the application of water by hand had to be done at frequent intervals and was done only with difficulty. The solution for the problem was finally found by applying to the belts a

mixture of glycerine and water. The glycerine being a heavy and not easily volatilized fluid, serves to hold the water on the belt for some length of time, thereby preventing electrification.

The ventilation of operating rooms and the maintenance of a proper humidity, greater than 40 per cent, is the best preventative of electrification.

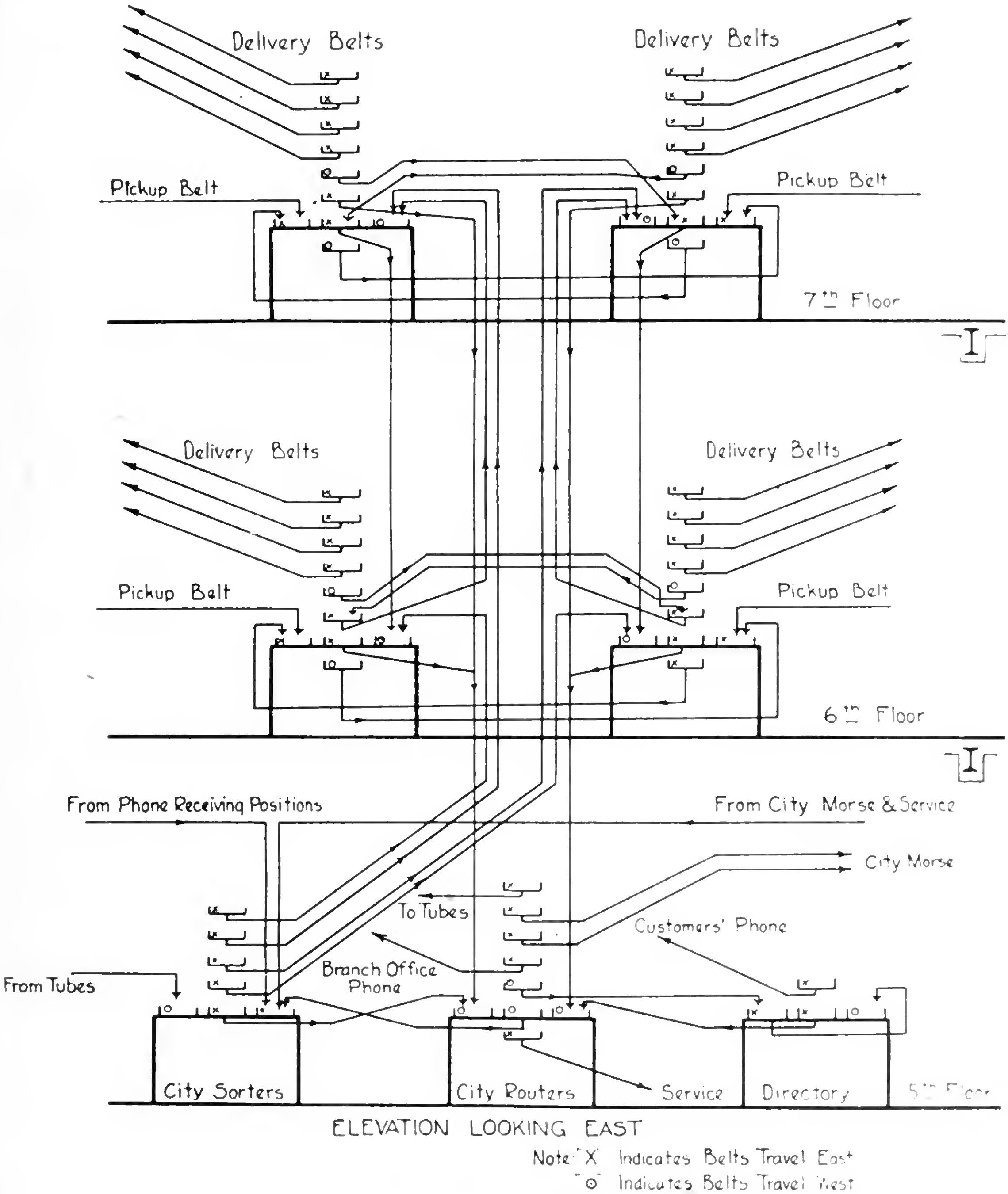

FIG. 19.—Schematic Layout of Chicago Belt Conveyors.

The motors connected for belt conveyor purposes aggregate 54 horse-power; of this amount 45 horse-power drive the belts, the remainder are reserve motors, each so placed that by shifting a driving belt, the reserve motor may be made to operate its particular belt conveyor.

There are 16,000 feet of conveyor belt in the Chicago installation or about 8,000 feet of belt conveyor structure. The longest belt is a two-way belt, serving

two points 150 feet apart. The highest riser is one between the fifth and seventh floors and is 35 feet high.

Pneumatic tubes also form an indispensable part of the large modern office. Most of the large offices within one mile of the main office are connected with it by underground pneumatic tubes. The various parts of the building are con-

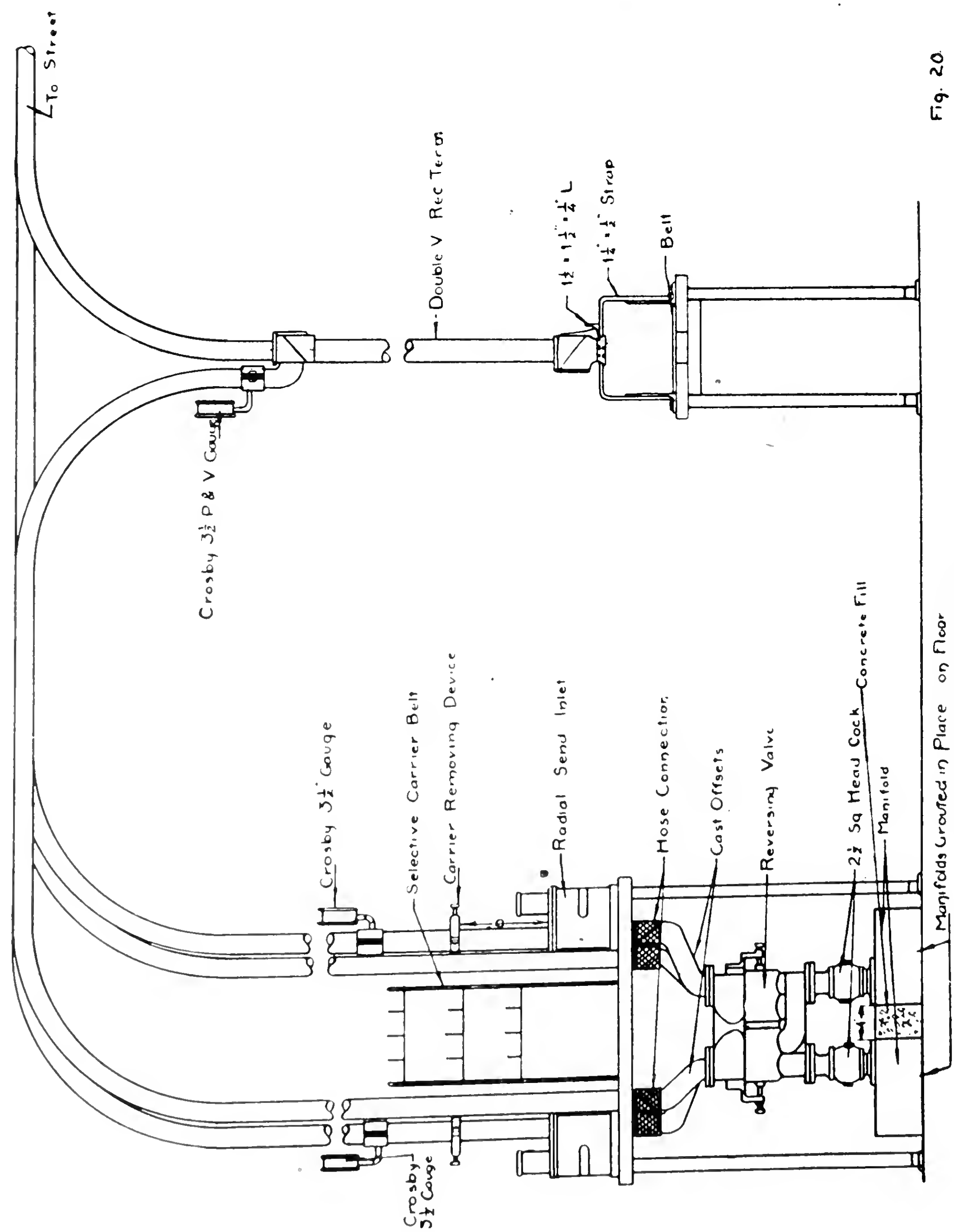

FIG. 20.—Elevation of Tube Center.

nected to the center by house tubes. The Western Union uses a 2¼-inch inside diameter tube. A 16-gauge steel tube is employed inside of the building; a 14-gauge copper tube is used for underground work.

The tubes receive their power from air compressors located in the basement; the tube center is on the fifth floor. Five Laidlaw 14-inch by 17-inch air compressors compose the power plant. These compressors are furnished with feather valves, one of the lightest and quickets acting valves with which we are

familiar. These valves are thin strips of steel, seating on slots slightly narrower, and held in place by a curved cover. Each compressor is driven by a 35-horsepower variable speed motor.

The compressors are divided into two groups, high and low pressure, although both groups are so piped that they may be run together at one pressure. Pipes leading from the compressors terminate in manifolds or headers on the fifth floor. These headers connect through valves to the terminals. Fig. 20 shows an elevation o fthe tube center. It will be noted that there are pressure and vacuum manifolds: the sending inlets are connected to the pressure manifold and the receiving terminals to the vacuum manifold. The reversing valve shown makes it possible to reverse the flow of air in any tube, i. e., to put vacuum on a sending tube and pressure on a receiving tube. This, of course, will reverse the

FIG. 21.—Commercial News Department.

direction of travel of the carrier in the tube. When a tube becomes blocked, this condition usually being caused by the insertion of foreign matter in the tube, it may be necessary to use the reversing process to clear the block. Belt conveyors are used to make more efficient the operation of the tubes. The receiving terminals used are of the automatic discharge type, and deliver carriers upon a belt which is directly underneath. All carriers are then conveyed to a central unloading point, where the messages are unloaded, timed and sent to the distributing center by belt. The sending inlets are served by another set of belts, each of which distributes carriers to a group of four inlets. The carriers are loaded at a central point and placed on the belts. Carriers are painted distinctive colors so that there will be no confusion respecting their destinations.

There are 24 pairs of branch office tubes which connect 23 branch offices with the main office (not counting relay offices). These tubes represent an aggregate length of 128,100 tube feet. As previously mentioned, the longest tube is 5,106 feet and the shortest 787 feet. The average speed to be expected of a carrier in a long tube is 20 feet per second. This is considerably exceeded in short tubes.

The longer tubes will probably be worked on 14 inches vacuum and 7 pounds pressure. When tubes of unequal length are on the same manifold, allowance is made by throttling the air inlets on the shorter tubes.

Commercial News Department.—The Commercial News Department or the C. N. D., as it is known to telegraph employees, consists of certain morse

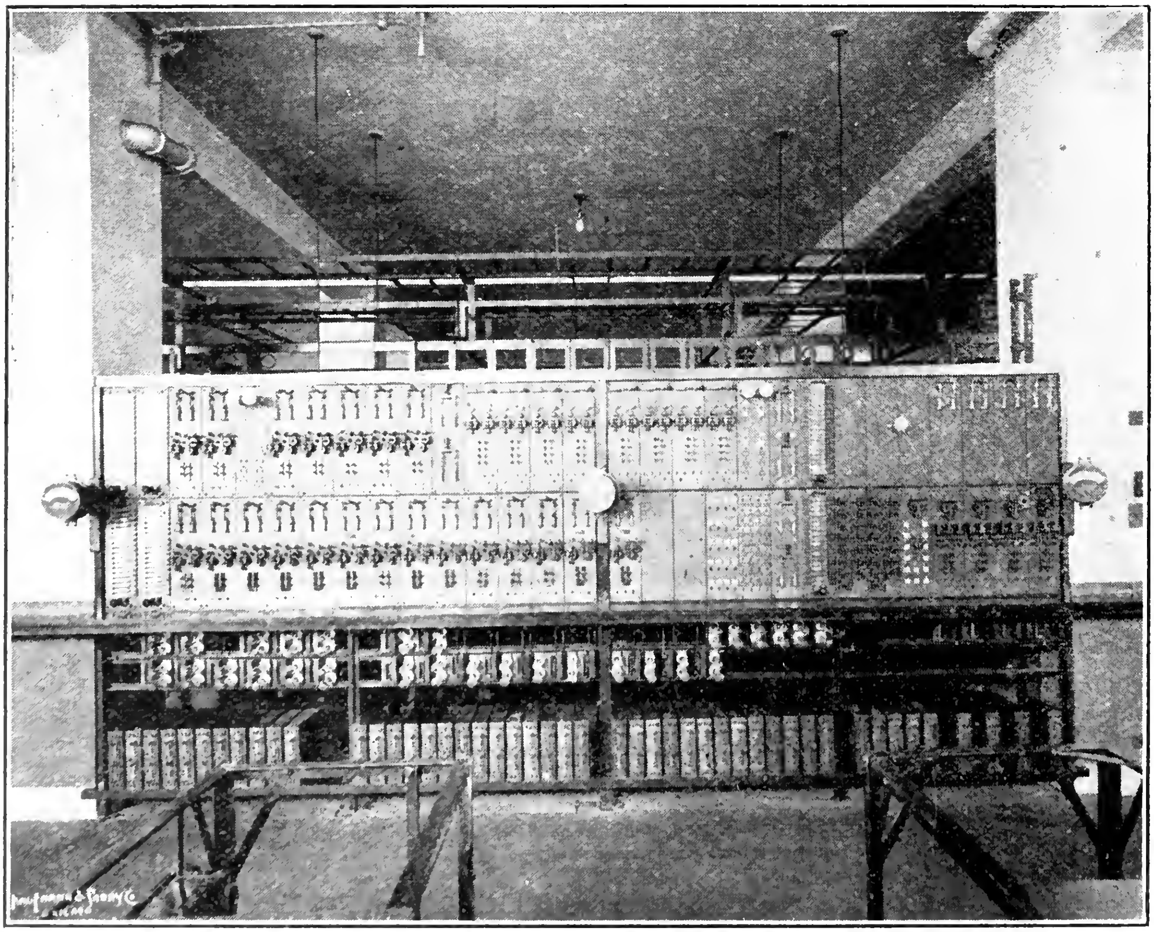

FIG. 22.—Ticker Switchboard.

wires and the familiar ticker. The Chicago C. N. D. is shown in Fig. 21. Quotations of stocks, bonds, wheat, cotton, etc., and results of sporting events are sent and received over the morse wires. Quotations and news are distributed locally and to nearby towns by tickers.

Ticker quotations are sent by an operator who operates a keyboard located on one of the operating tables. One type of keyboard resembles the keyboard of a piano; another type of keyboard consists of a piece of slate about twelve inches square, mounting keys placed in concentric circles. The keyboard operates a transmitter which in turn sends the impulses to line.

There are three types of tickers in Chicago which are used to give five separate kinds of quotations. *Self-winding* tickers are used for New York stock

quotations, *Burry* tickers are used for grain, baseball and cotton quotations; *Universal* tickers are used for local stock quotations. Fig. 22 shows one section of the switchboard, of which there are three altogether. There are fifty-eight ticker circuits operating 773 tickers in the Chicago district.

Time Service Department.—All of the Western Union clocks with which you are familiar are synchronized from a central point in the testing and regulating department on the third floor, see Fig. 1. There are five sections of time service switchboard with apparatus for 180 synchronizing circuits and 12 seconds beating circuits mounted thereon. Of the synchronizing apparatus, there is provision for 140 combined time messenger circuits. This latter type of apparatus is such that a circuit containing both call boxes and clocks may be operated over the same line wire. It is possible to do this for the reason that the synchronizing

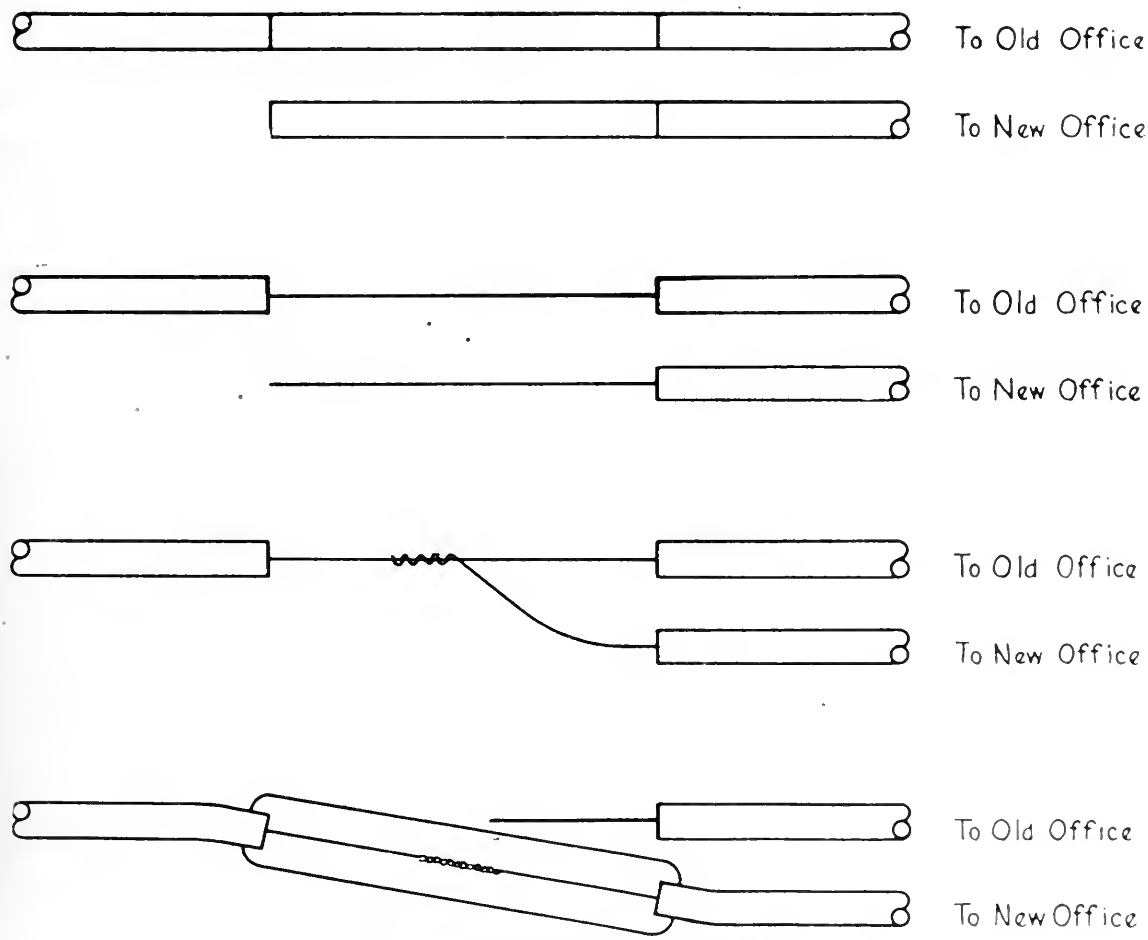

FIG. 23.—Theoretical Cutover of Wire.

impulse is sent out only once each hour for a duration of one second. During this second the call circuit central office apparatus is disconnected Call circuit impulses last for so long a period that at least one perfect signal will be received, even if it takes place exactly on the hour while the synchronizing impulse is being sent out. The call circuit equipment on the time service wire acts as an excellent trouble detector; any circuit trouble such as a ground, open, etc., is shown up at once.

Time service synchronizing equipment is extremely simple: it consists of a number of relays controlled by a master relay; the latter is controlled by a contact inside of the master clock, this contact closing for one second at the beginning of each hour. The seconds beating service consists of a number of circuits

upon which are sent out impulses at each second except for certain impulses which are omitted in order to identify the beginning of each minute. These circuits are used principally by jewelers who receive the impulses on sounders. The equipment on these circuits consists of a number of relays controlled by a master relay which, of course, is controlled by contacts inside of the master clock.

The master clock is compared each noon with the Washington Observatory time, which is sent daily all over the country on Western Union wires. If the master clock should be a fraction of a second out of the way, it is regulated by adding to, or removing from, the pendulum a small weight. This is done without disturbing the motion of the pendulum.

There is no call circuit equipment at present located in the new building, the old equipment being retained in the old commercial office on Jackson Boulevard.

FIG. 21.—Operating Room, Sixth Floor.

CONCLUSION.

Having described the builidng and the equipment contained therein, it will be interesting to conclude by describing briefly the *cutover*, or the moving of the office.

When a large office "moves," very little moving actually takes place, except for such equipment as desks, typewriters, storage cabinets and filing racks, drawers and cabinets. The majority of the equipment is installed before the cutover takes place so that the actual breaking of the wire connection in the old office, and the making of the wire connection in the new, is all that is necessary.

Cutovers are generally organized according to a schedule: when a wire is cut from the old office to the new there will be an operator at the new office ready

to continue with the sending and receiving of messages at the point left off by the operator in the old office. Wire chiefs, assistant chief operators, clerks, distributing center sorters, check boys and girls have all been given instruction concerning the operation of the new office, so that when they move over, everything will move along smoothly.

The actual cutover of the wires takes place in a manhole which is located in a convenient position with respect to the two offices. Fig. 23 shows simply how the "cut" is made. At the top are seen two cables, one passing through a manhole to the old office and one extending to the new office. Below both cables are shown with the sheath stripped off; for convenience, only one conductor in each is shown. In the third view the conductors are shown spliced. This is known as a half tap. The wire to the old office continues to operate—at the same time the conductor to the new office is tested out. When the "cut" is made, the wire to the old office is cut as shown in the lower diagram.

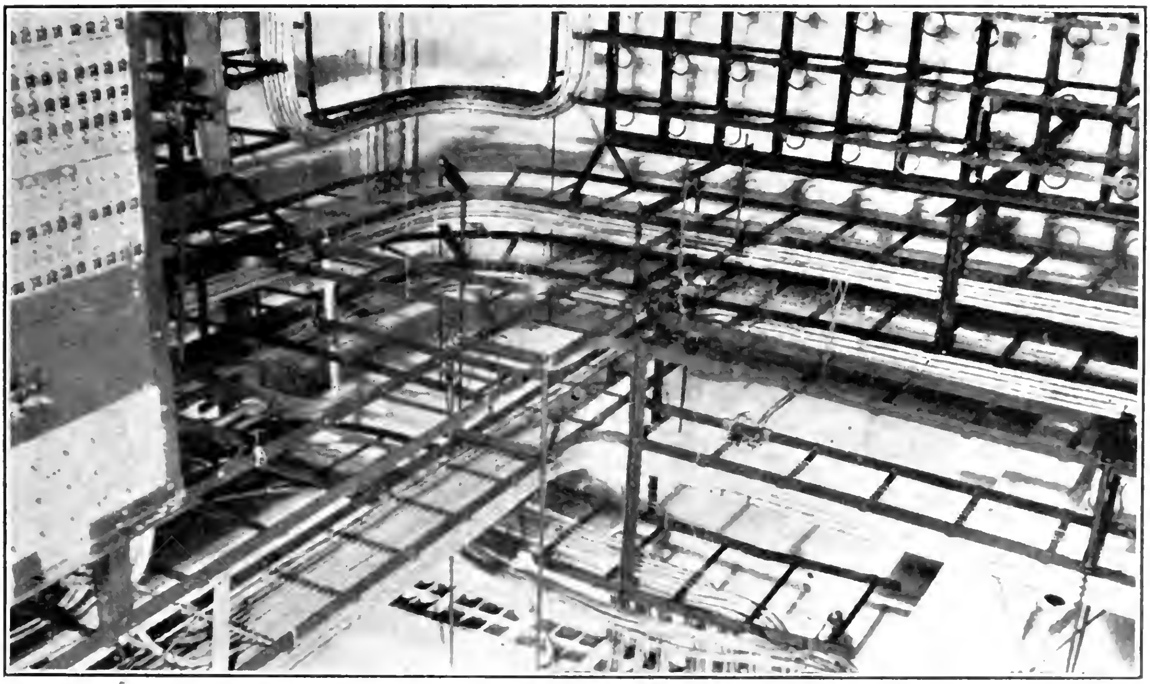

FIG. 25.—Cable Rack.

Before the cutover takes place, the wire in the new office has already been connected to a jack in the switchboard. This jack is held open and inoperative by means of a dummy or wooden plug. At the scheduled time the plug is withdrawn and the wire is permanently in operation.

To one in the new operating room the cutover comes so gradually that it is hard to tell that it is taking place, except that operators will be seen to come in, take their places and in a short time begin to work their wires.

The Chicago cutover because of its size has been made in steps. This was made possible by the use of pneumatic tubes between the old and new buildings. The C. N. D. was cut over in April, 1920. The sixth floor, and a part of the fifth floor were cut over in December, 1920. The remaining part, consisting principally of multiplex printing telegraph wires, was cut over in January, 1921. All of the cutovers took place without any appreciable trouble.

THE DEVELOPMENT OF PRINTING TELEGRAPHY

By J. O. CARR.*

Presented January 6, 1921.

As the development of printing telegraphy is rather a large subject to consider in its entirety, I shall confine myself to those systems which have had an influence on the development of systems in use in the United States today.

Electric telegraphs first made their appearance about the year 1800, not long after Volta discovered that electricity could be generated by chemical means. Many of these systems were visual while others were chemical telegraphs. They made marks on chemically impregnated paper, due to the decomposing action of the received currents.

About 1824 the electro magnet was discovered and in 1837 Morse, making use of this discovery, invented the electric magnet telegraph. After Morse there were many attempts at type printing telegraphs but the first successful one was the Hughes, invented by an American in 1855. This system found no permanent place in the United States, but taken to Europe it found wide application, especially on the Continent, where it became the standby of many telegraph administrations. It is still widely used there today.

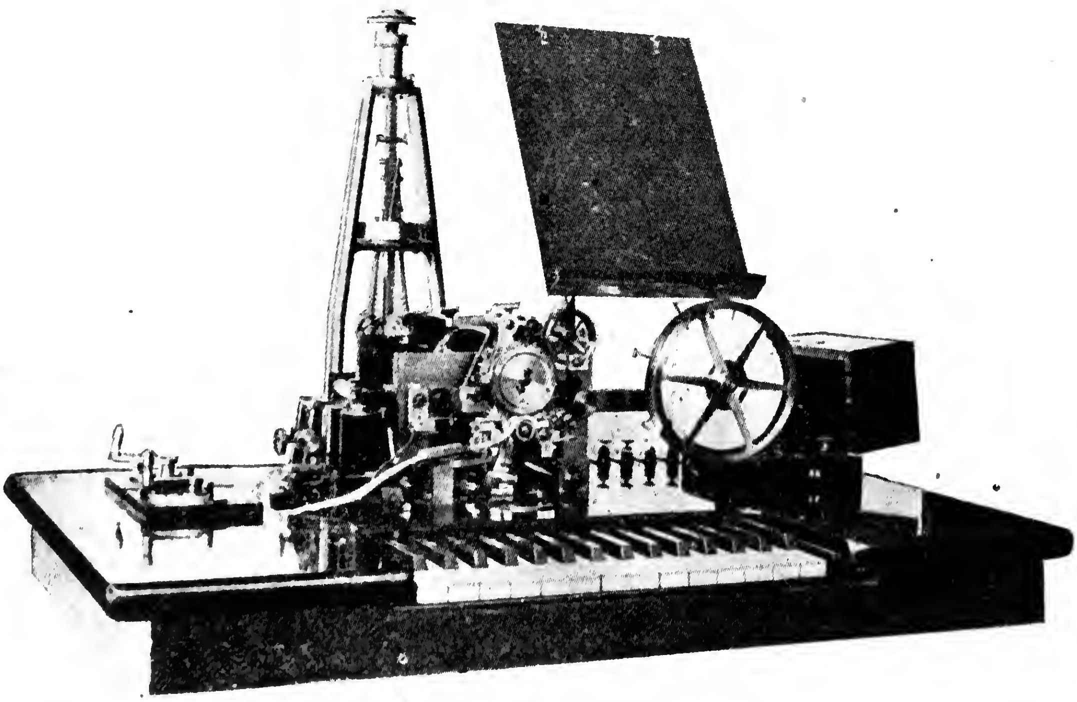

FIG. 1. Hughes Printer.

Figure 1 shows the Hughes printer. It is a typewheel printer. The typewheels at the opposite ends of the line revolve in synchronism. The tape passes over a printing roll beneath the typewheel and to print a letter a current impulse is sent over the line timed to arrive when the desired letter on the typewheel is just above the printing roll. The printing arm is released and the tape is thrown against the typewheel and the letter printed. The transmitting keys, one for each letter, are similar to piano keys.

In 1875, when Baudot developed his Multiplex system, he employed the Hughes printer and later when he made a printer unit of his own, he utilized much of the Hughes design in the printing portion of his machine.

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It is strange in view of the fact that an American, Morse, invented the telegraph, and that the first telegraph was a recording one, that up until a few years ago printing telegraphs were little used in this country, though widely used abroad.

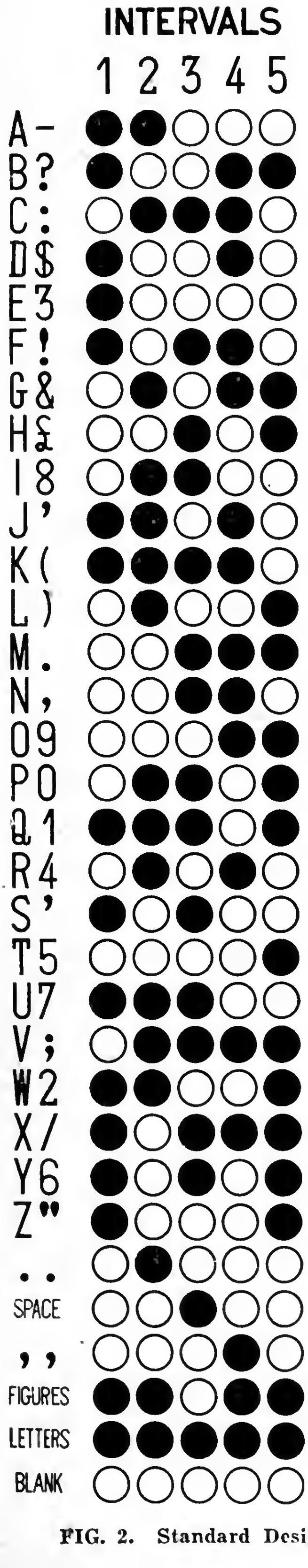


FIG. 2. Standard Designation of the Five-Unit Code Combinations.

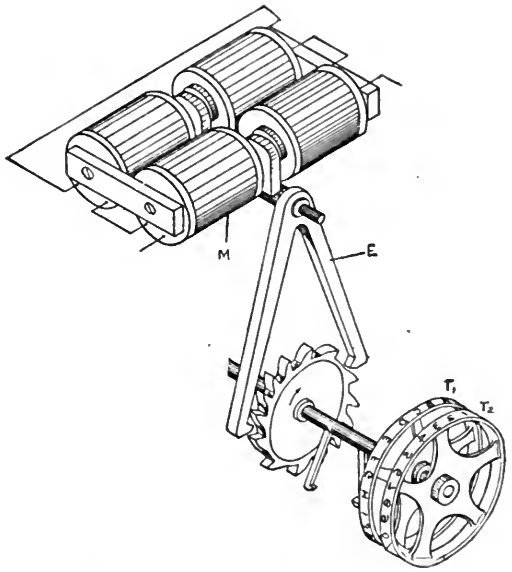


FIG. 3. Ticker Mechanism.

This was probably due to the fact that the Americans have a knack for learning sounder Morse and the Europeans have not. With an adequate supply of high grade sounder operators, the telegraph companies were loathe to adopt a more complicated system, for it is self-evident that sounder Morse is the simplest form of telegraphy. There are two general requirements which printing telegraphs must meet in order to secure adoption.

1. They must save line.
2. They must save labor.

Under certain conditions one of these requirements is met at the expense of the other. Over long lines the first requirement is of greatest importance on account of the heavy investment and maintenance charges of the line. It is conceivable that a long line may be so valuable that it will pay to increase the labor cost 100 per cent to secure a 50 per cent greater utilization of the line.

Some printing telegraphs have met one or the other of these requirements, while some have met both. I believe that the present day systems in use by the telegraph companies save both line time and reduce the operator cost per message.

The foundation of any printing telegraph system is its signalling code. The code is first determined and the apparatus then built to fit it. It can be said that a printing telegraph is only as good as its signalling code.

The best code is the one using the least number of signalling elements per letter combination. A code in which all combinations are of equal length also has a great advantage when considered from the standpoint of the apparatus built to handle it.

For printing telegraphs it is necessary to save at least twenty-eight signal combinations. This takes care of the twenty-six letters of the alphabet and the shift to change to figures and upper case characters and an unshift to change back.

Twenty-eight combinations are sufficient if the printing is on a tape, but if the printing is on a page it is necessary to have two additional combinations, one to feed up the paper and another to return the carriage to start a new line. This means a minimum of thirty combinations when page printing is desired.

Assuming two line conditions, positive or negative current flowing; or current and no current, we find that the least number of elements which will give enough combinations is five. In other words, two conditions of the line varied through five portions of an interval of time, will give thirty combinations. Counting the two arrangements when all five intervals are alike, we get a total of thirty-two.

Figure 2 shows the standard designations of the five unit code combinations. The black circles represent a flow of current which will affect the selecting mechanism, or in telegraph parlance "marking" intervals while the white circles or "spacing" intervals serve merely to properly locate or space the marking intervals.

It is true that by using more than two variations of the line condition, a sufficient number of combinations can be secured with less than five elements. For instance, we might use positive, negative and zero; or strong, weak and zero. However, experience has taught us that such signals are impractical. The best results and highest speeds, especially over long lines, are secured by signals made up only of positive and negative intervals. Current, no-current, signals give satisfactory results at lower speeds or over short and well insulated lines.

It is interesting to note that all successful printing telegraphs used in this country today employ the five-unit code.

This code is frequently referred to as the Baudot Code, as it first came into wide use in the Multiplex system, invented by a Frenchman, named Baudot, in

1875. This system is widely used abroad, especially in France and other European countries.

The most elementary code that could be devised is perhaps one in which one letter is designated by one element, the next by two, and so on. This is the sort of code used by the stock tickers which are of the class of printing telegraphs known as step by step.

Figure 3 shows a ticker mechanism. The typewheel and escape wheel are mounted on a shaft driven by a spring or a weight. The line signal consists of a succession of current alternations which pass through the magnets and operate the escape and allow the typewheel to rotate step by step. To select the eighth letter on the typewheel, eight alternations are transmitted when printing is effected by allowing steady current to flow which causes the printing magnet to press the tape against the selected letter.

Another form of code is one in which the signals are made up of combinations of long and short elements. The Morse Code is of this class, being made up of dots and dashes, the latter being three times as long as the former.

In this sort of code it is essential that there be an interval between successive elements of the code whether they are alike or different.

Taking the dot as the unit of measurement, the Morse letter H, which is four dots, is eight units long, as each dot is separated by a dot length space, and there must be at least a dot space at the end of a letter.

With the five unit code there is no necessity for a space between successive intervals whether they are alike or different. Each letter combination is, therefore, only five units long.

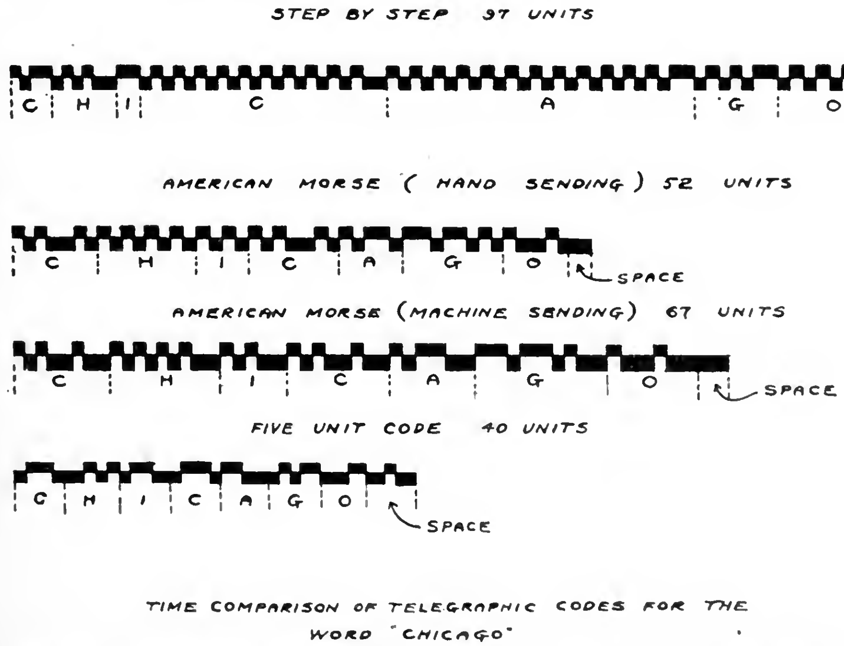


FIG. 4. Comparative Length of Line Signal Required to Send the Word Chicago by Means of Various Codes.

Figure 4 shows the comparative length of line signal required to send the word Chicago by means of various codes. The step-by-step code is the longest while the five unit code is the shortest.

You will note that machine Morse is longer than hand Morse because of the fact that with a Wheatstone transmitter, which is generally used for automatic Morse transmission, the space between letters cannot be less than a dash length. This is inherent in the machanism. With hand sending a Morse operator generally makes a dot length space between letters.

The signalling speed of any line is determined by its length and other characteristics and can be expressed in cycles per second. Twenty cycles would mean forty dot length reversals per second. It is obvious that if the line frequency is limited that more words per minute can be transmitted using the five unit code, than by using any other code, or if the limit of speed is not approached there will be more margin under adverse conditions with the five unit code than with any other. This explains why all printing telegraph systems in this country have adopted this code as standard.

In this talk reference will be made to two broad classes of printing telegraph systems:

1. Single channel systems, which provide a single transmission over a wire in one direction, or if duplexed, one transmission from either end simultaneously.
2. Multiplex systems, which provide from two to four channels in each direction, when duplexed.

Baudot, who has been previously mentioned, developed a remarkably successful Multiplex system, which has been made the basis for all present day successful Multiplex systems. He employed rotary distributors for the transmission and reception of the signals. In principle his system consisted of a segmented ring having twenty insulated segments.

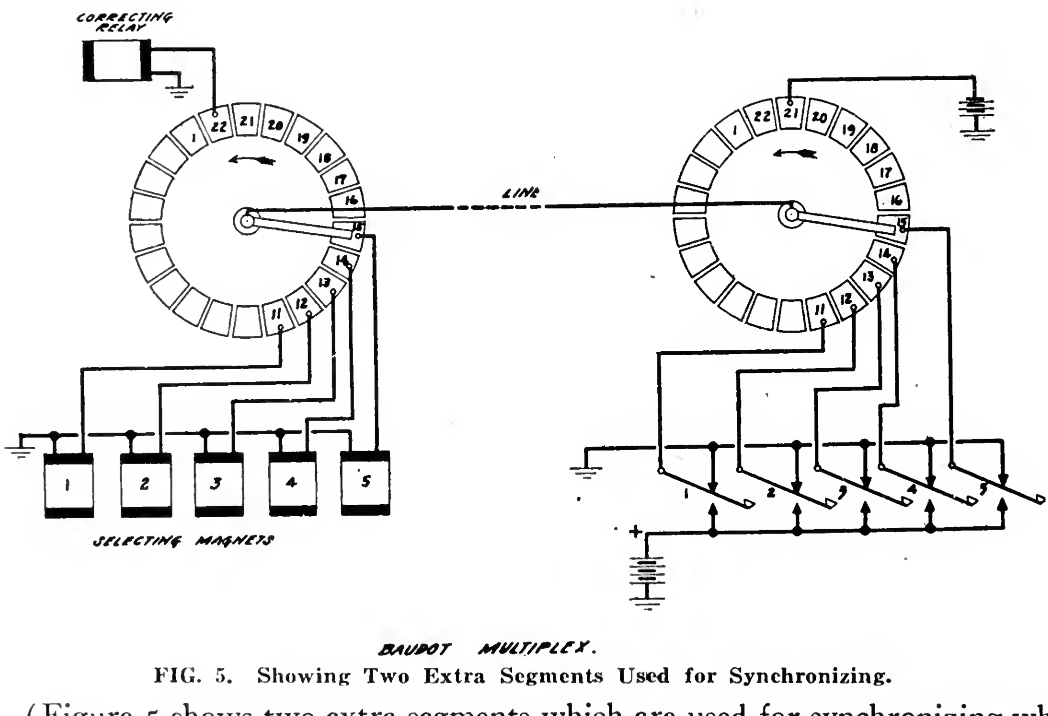


FIG. 5. Showing Two Extra Segments Used for Synchronizing.

(Figure 5 shows two extra segments which are used for synchronizing which will be referred to later.)

These were divided into four groups of five each and each group was connected to a set of five keys. The line wire was connected to the brush which rotating at a uniform speed, swept over the twenty segments and connected them successively to the line wire.

At the receiving station was a similar device, but with the segments connected to four sets of receiving magnets. If the brushes at the two ends of the line are revolving in unison, each group of receiving magnets will receive the signals set up by the corresponding group of transmitting keys.

Of course, the keys cannot be manipulated while the brush is passing over the corresponding segments, but Baudot provided for this by having a cadence

tapper operated from a local contact on the distributor. There was one for each group of keys. The tapper was energized just before the brush reached the channel corresponding to the group and when the operator heard the tap he knew that he could change the setting.

Of course, the Baudot distributor had mechanism for keeping those at opposite ends of the line in unison. A very constant speed of drive was secured by means of a weight driven clock train and to take care of small speed variations, he also had a very delicate governor. However, with even the slightest speed difference, between the two ends, the distributors would soon get out of unison. To prevent this, instead of having his brush rigidly fixed to the driving shaft, he connected it to the shaft by means of gears and through the use of a star-wheel and a detent held the brush stationery with reference to the shaft. He desig-

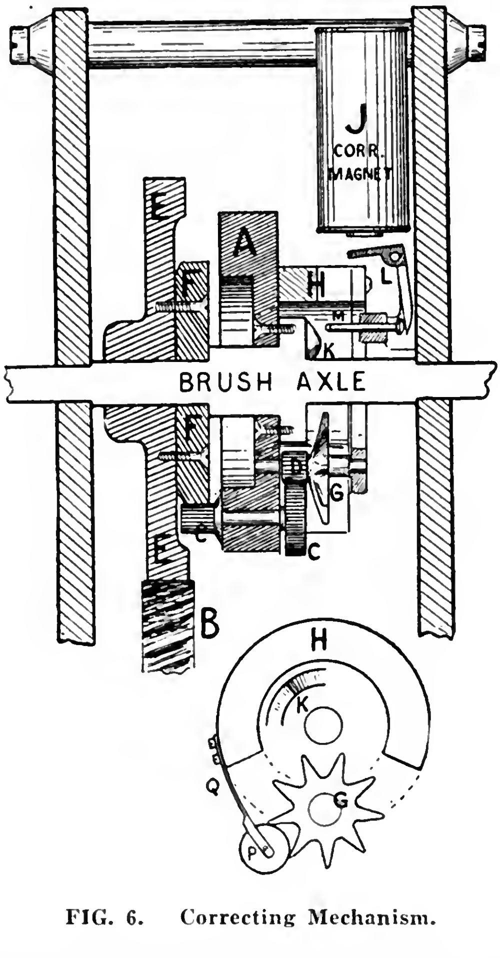


FIG. 6. Correcting Mechanism.

nated the station at one end of the line, the correcting station, and the opposite one the corrected station, and he drove the distributor at the corrected station slightly faster than the one at the correcting station.

In addition to the transmitting impulses the correcting station sent out a correcting impulse each revolution. If the brush of the corrected station had advanced far enough to allow this correcting impulse to fall on the segment to which the correcting magnet was connected, a pin would be interposed in the path of the star-wheel and the brush would be retarded slightly. Of course, this process would be repeated each time the brush had crept ahead a certain definite amount.

Referring to Figure 5. The correcting impulse is sent when the brush passes over segment 21. If the receiver brush is then on segment 21 there will be no effect but when the receiver brush advances far enough so that it is partly

on segment 22 when the correcting impulse is received, the correcting magnet will be actuated.

Figure 6 shows the correcting mechanism. The brush axle carries a plate rigidly fastened to it. A short shaft carrying two gears C passes through this plate. The left hand gear C meshes with gear F attached to drive gear E which is loose on the brush axle. The right hand gear C meshes with pinion D, attached to star-wheel G. This star-wheel is prevented from turning by detent roller P, shown below. This arrangement causes the brush axle to be driven just as if the drive gear was fastened to it.

However, when correcting magnet J is energized it attracts armature L and pushes pin M into the path of G. As G revolves the pin will engage one of its points and turn it one tooth. This will shift the brush backward on tooth with reference to the drive gear.

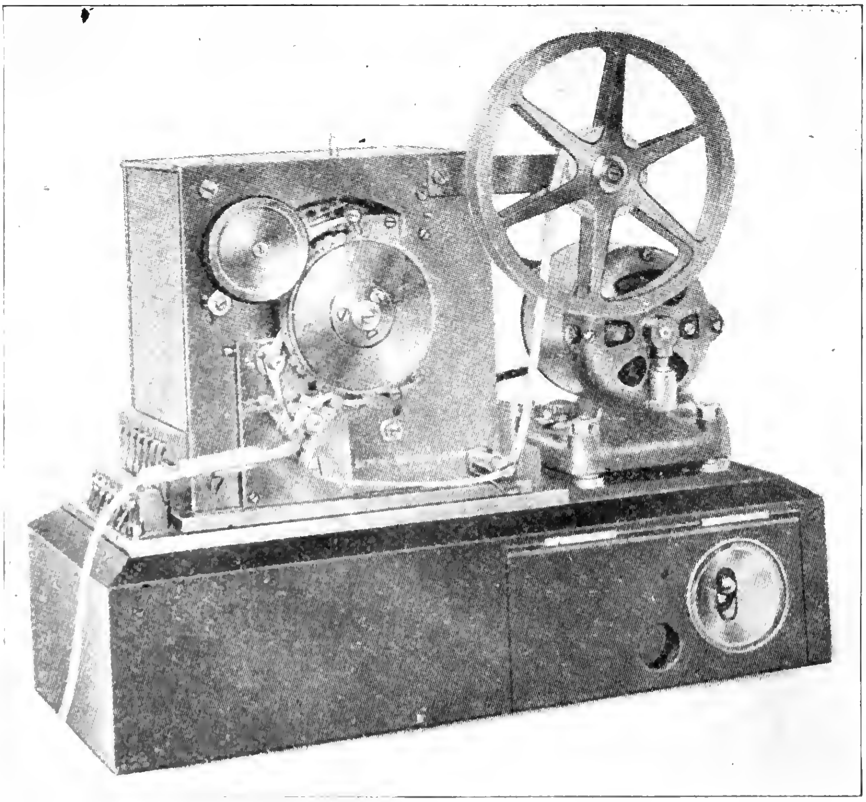


FIG. 7. Baudot Printer.

Baudot at first employed the Hughes printer in connection with his Multiplex system but later developed a very simple and study printing unit, which printed in Roman characters on a tape, which was then gummed to the message form.

Figure 7 shows the Baudot printer. The letters of the alphabet are engraved on the rim of a steel wheel. As in the Hughes printer the tape passes around a printing roll on an arm beneath the type-wheel and to print a letter the arm is released, causing the tape to press against the type-wheel and receive the impression.

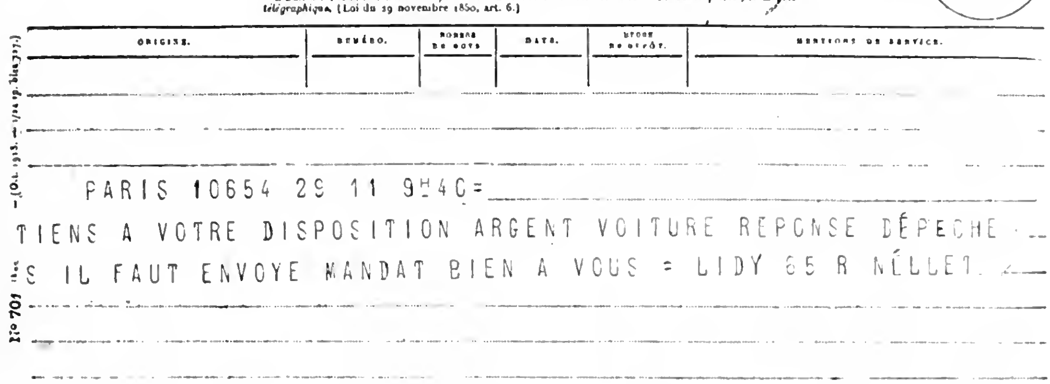
While the bulk of the French telegraph traffic has been handled on the Baudot for many years, it never came into use in this country. There were many reasons for this:

1. The speed adjustment by means of the Baudot Governor is very delicate, requiring long experience and a great deal of patience to secure good results.

2. The Baudot printer prints on a tape which is then gummed to the message blank. The American idea was to have the printer print directly on the blank.
3. The operation of the Baudot keyboard requires considerable training. Instead of merely striking a typewriter key to send a letter, the Bandot operator

FIG. 8. Baudot Keyboard.

must know the code combination for the letter and press the keyboard keys in proper combination to form it. In addition he must manipulate the keys at just the right time to take advantage of every revolution of the distributor. His skill and training too nearly approach that of a Morse operator.



Signification des principales indications éventuelles pouvant figurer en tête de l'adresse.

D ..... = Urgent.	XPr.... = Exprès payé.
AR..... = Remettre contre reçu.	NUIT... = Remettre même pendant la nuit.
PC..... = Accusé de réception.	
RP..... = Réponse payée.	JOUR... = Remettre seulement pendant le jour.
TC..... = Télégramme collationné.	
MP..... = Remettre en mains propres.	OUVERT = Remettre ouvert.

Indications de service.

Dans les télégrammes imprimés en caractères romains par l'appareil télégraphique, le premier nombre qui figure après le nom du lieu d'origine est un numéro d'ordre, le second indique le nombre de mots taxés, les autres désignent la date et l'heure de dépôt.
Dans le service intérieur et dans les relations avec certains pays étrangers, l'heure de dépôt est indiquée au moyen des chiffres de 0 à 24.

L'État n'est soumis à aucune responsabilité à raison du service de la correspondance privée par la voie télégraphique. (Loi du 29 novembre 1850, art. 6.)

N°

Timbre à date.

ORIGINE.	NUMÉRO.	NOMBRE DE MOTS	DATE.	HEURE DE DÉPÔT.	MENTIONS DE SERVICE.

PARIS 10654 29 11 9H40=

TIENS A VOTRE DISPOSITION ARGENT VOITURE REPONSE DÉPECHE

S IL FAUT ENVOYE MANDAT BIEN A VOUS = LIDY 65 R NÉLLET

N° 701

FIG. 9. French Baudot Message.

Figure 8 shows the Baudot keyboard. It has five keys similar to piano keys. They are divided into two groups. Starting at the center, the right hand group is numbered 1, 2, 3, and the left hand group 4, 5. That is the outside keys are three on the right and five on the left.

Figure 9 shows a French Baudot message.

Owing to the prejudice against certain features of the Baudot system, most inventors overlooked the advantage of the five unit code used by Baudot and development proceeded along other lines.

The Wheatstone automatic system, while not strictly a printing telegraph, came into wide use in this country and had considerable influence on several

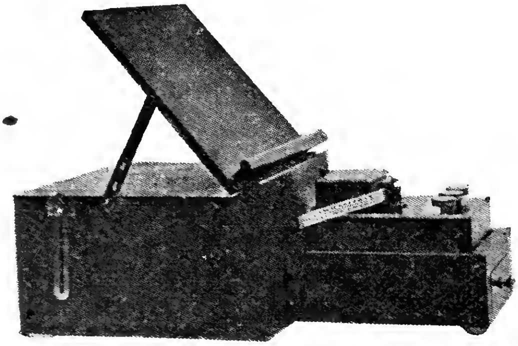


FIG. 10. Mallet Perforator.

printer systems which were developed here later. The Wheatstone is an automatic Morse system and was invented by Wheatstone in England in 1858.

Instead of sending the Morse signals by hand, perforated tape is prepared and run through a transmitter which sends the dots and dashes over the line at a high rate of speed. At the receiving end, a relay carrying an inking wheel prints the dots and dashes on another tape. These tapes are then translated and transcribed onto message forms by typewriter or longhand.

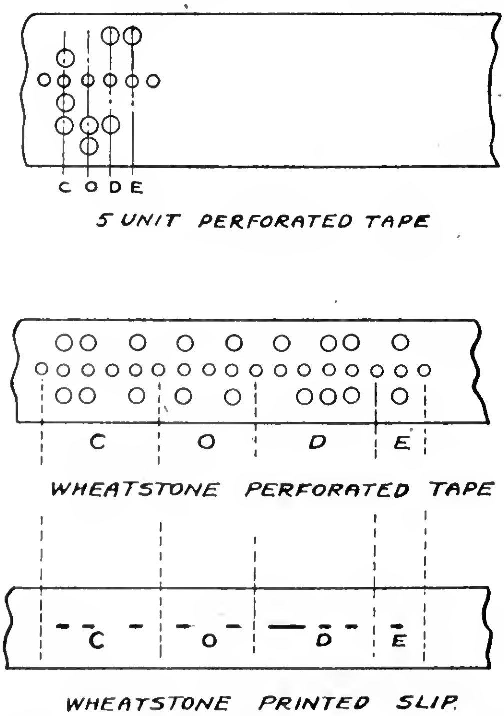


FIG. 11. Specimen of Wheatstone Perforated Tape and Corresponding Receiving Tape.

Figure 10. Mallet Perforator.

The first perforator used for the preparation of this tape had only three keys, one for the dash, one for the dot, and one for the space. The operator, who must know the code combinations, struck these keys with small mallets and thus perforated the Morse characters in the tape.

Figure 11 shows a specimen of Wheatstone perforated tape and the corresponding receiving tape. You will note that a dot is indicated in the perforated tape by two holes directly opposite, while a dash is produced by two in a slanting position. A specimen of five unit perforated tape is shown to illustrate the saving in tape with the five unit signals perforated across the tape.

Figure 12 shows the mechanism of the Wheatstone transmitter. A rocking bar RB is rocked by means of an eccentric geared to the drive shaft. Through the pins P and P' arms A and A' are alternately moved up and down. The pins S and M are alternately moved up against the tape and when there is a hole the pin passes through and by means of the corresponding push rod R or R' the lever L is moved against one of the contacts D or D' and the current polarity on the line is reversed.

Later, perforators having typewriter keyboards came into use. This system was capable of very high speeds. In England it has been operated at speed of two hundred to four hundred words per minute, but no such speeds were secured in this country, partly because the lines were longer and operated duplex, while abroad they were frequently operated simplex.

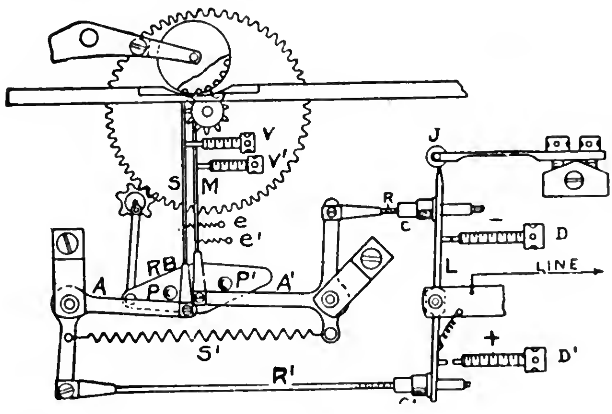


FIG. 12. Mechanism of the Wheatstone Transmitter.

The Wheatstone had certain objectionable features. Perhaps the two most objectionable were, that while the tape was transmitted at a high rate, there was a considerable lapse of time from the start of the preparation of the message to its actual transmission, and at the receiving end there was a delay from the time a message was received until it was transcribed. If there was an error in the message it was not discovered until it had been transcribed and it was then subject to a delay until a message could be sent to the transmitting station and a reply received. These service messages were given preference but even so the message held for correction was apt to get pretty old.

To overcome the delay at the receiving end inventors went to work to provide apparatus which would translate the dots and dashes into printed characters.

An Englishman, named Creed, perfected a very ingenious machine which caused the received signals to control a pneumatic perforator which produced a perforated tape at the receiving end, identical with that used for transmission. This tape was then fed into a printer and mechanically controlled a number of slide valves, which allowed compressed air to act on pistons and operate type bars to print in Roman characters on a tape. At this printer operated at high speed, and was placed adjacent to the receiving perforator, the transcribing delay of the Wheatstone was practically eliminated. This system has been very successful in

England but as it is very expensive to install and to operate, it has not been adopted in this country.

The Buckingham printer which was developed for the Western Union, used Wheatstone transmission and page printing reception. Buckingham was unable to use the Morse code because of his unison device which required that each signal be made up of the same number of elements.

He adopted adot dash code in which each signal was made up of three dots or dashes. That is, a dot and two dashes, or two dots and a dash, etc. The elements of the combination were separated by either dot or dash spaces and succeeded always by a dash space so that his code was very long. The shortest possible signal was eight units long and the longest eighteen. This limited his transmission speed. The Buckingham did not come into general use and was followed by the Barclay which was an improved form of the Buckingham.

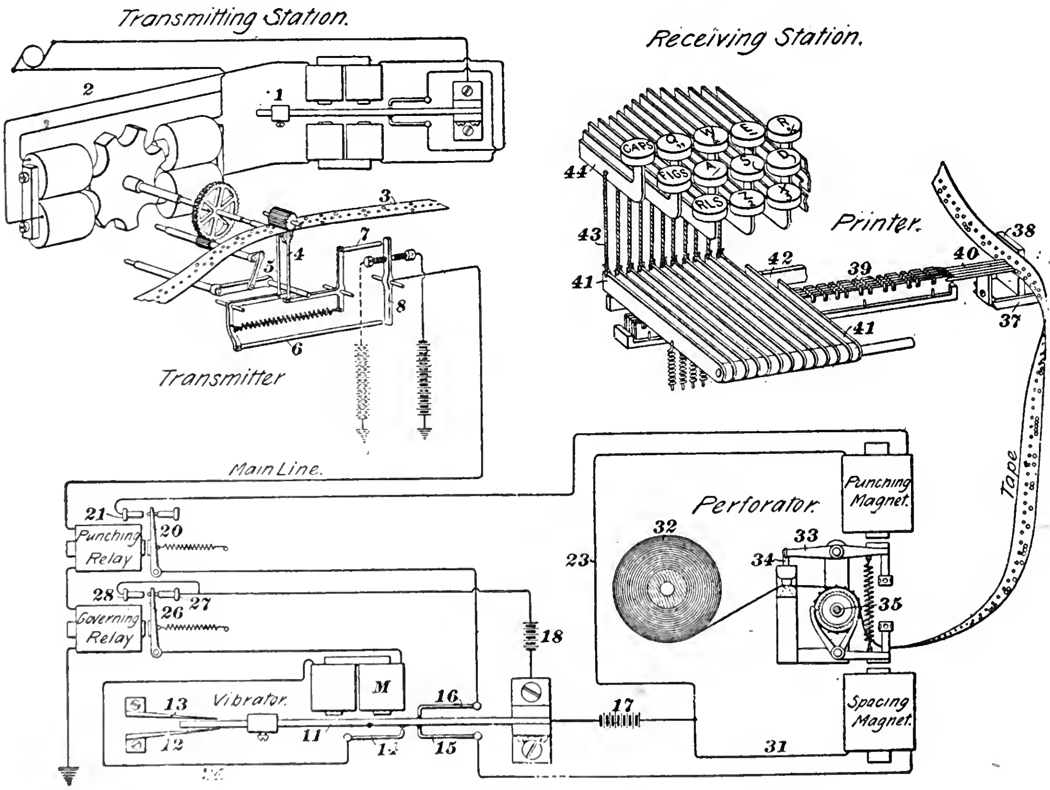


FIG. 13. Murray Automatic.

Barclay used the same code and transmission but he used a Blickensderfer electric typewriter for a printer. He replaced the keys with magnets, that is, a magnet for each letter.

His selecting mechanism, controlled by the received signals, would set up a path to the proper letter magnet and the long spacing impulse at the end of each signal would send current into the magnet, printing the letter.

The Barclay came into wide use with the Western Union as they had at one time about sixty circuits in operation. However, the Barclay line signal was too long and his transmission had the objectionable features of a Wheatstone, so there are no Barclay circuits in operation today.

About 1900 Donald Murray, an Englishman, who has always been a most ardent advocate of the five unit code, came to this country and developed a system which was tried out by the Postal Telegraph Company. His system embodied a keyboard perforator which punched his code combinations

in tape of the same dimensions as Wheatstone tape. For transmission he used a modified form of the Wheatstone transmitter, but in order to secure a uniform transmitting speed he drove this transmitter by means of a tuning-fork and a phonic wheel. At the receiving station he had a tape perforator, driven by a vibrating reed or tuning-fork. Unison between the receiving perforator and the transmitter was secured by means of corrections generated from the letter signals, that is, no special correcting impulses were sent over the line.

By an ingenious arrangement, the code signals, in addition to perforating the tape, also corrected the speed.

The received tape was fed into the receiving printer and its perforations translated into typewritten characters on message blanks. This system was not extended and is not now used in this country.

Figure 13 shows the Murray automatic. In connection with his receiving pertorator he had two relays, a punching relay and a governing relay. The armature and contacts of the governing relay were in series with the driving magnet of the vibrator. As long as the received impulses were in step with the vibrator, the governing relay armature would always be against one of its contacts when the vibrator driving contact closed. If they got out of step the armature would be in transit when the driving contact closed and the impulse to the drive magnet clipped. This would increase the rate of vibration.

The next system tried out by the Postal was the Rowland Multiplex system, which was invented by Professor Rowland, the noted physicist. His system operated a maximum of four channels and by duplexing he secured four transmissions in each direction. His distributors, printers and keyboards at the two ends of the line, were all synchronized with each other.

He did not transmit any special correcting impulses but maintained synchronism in the following manner:

His distributors were driven by shunt motors which were set to run at the proper speed by means of rheostat adjustments. As in the Baudot, one end was designed as the correcting end, and the opposite the corrected. The corrected station had its motor set to run slightly faster than the correcting station motor.

In series with the armature of the motor at the corrected stations was a resistance which was shunted by the action of a polar relay in connection with a brush and commutator, driven by the motor.

The normal or idle line signal was pure alternating current which controlled two polarized relays at the receiving station, one for selection and the other for correction.

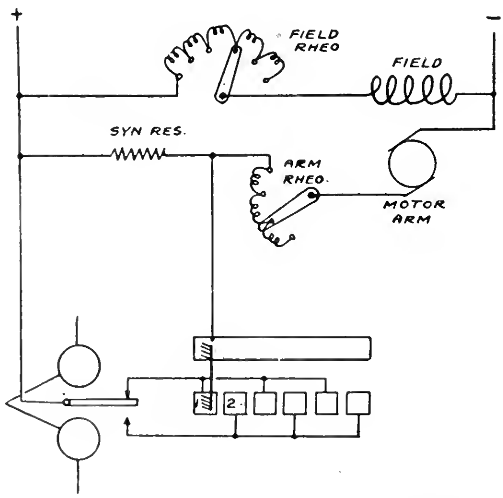
Figure 14.

This correcting relay had two contacts, one of which was connected to every other one of the segments on the correcting commutator. The other contact was connected to the alternate one, there being a segment for each half wave of the line signal. If the corrected station were running at the same speed as the correcting station, the relay would touch each contact at the instant that the brush was on one of the segments connected to that contact. This would shunt the resistance in series with the motor armatures, tending to speed it up. As the speed increased there would come a time when the brush would be partly on one of the second series of segments when the relay tongue was touching the contact connected to the first series. Thus the resistance would not be shunted for the full period and the speed of the motor would be decreased.

Rowland producd his letter combinations by reversing half waves of his normal idle signal. Because of this method of correction, however, he could not reverse many of the half waves or his distributors would get out of unison. He

was, therefore, forced to use eleven half waves, which allowed him to secure enough combinations by reversing only two. He added three extra half waves which he used for auxiliary signals and thus his line signal was 14 units long. Consequently, on a four channel outfit, operating at thirty-five words per minute per channel, his line frequency was 98 cycles. This was extremely high and produced disturbances on adjacent wires of the pole line and was one of the reasons why his system was abandoned.

Rowland did not use tape for transmitting purposes. He used direct keyboard. That is, when the operator pressed the key the corresponding signal combination was set up and sent over the line. As in the Baudot system, the keys could not be manipulated while the brush was passing over the segments assigned to that set of keys. He, therefore, had to make use of a cadence device, which took the form of a locking mechanism, preventing a key being depressed, except at the proper time, and holding it depressed while the brush was passing over the transmitting segments controlled by it.



SYNCHRONIZING CIRCUIT ROWLAND SYSTEM

FIG. 14. Synchronizing Circuit, Rowland System.

This cadence keyboard was objectionable because it required considerable training in order that an operator would take advantage of every revolution of the distributor to send a letter over the line. It was necessary for the operator to strike her keys with machine-like regularity, otherwise the utilization of the line would be inefficient.

Rowland used a tape printer to produce a home record and a page printer at the receiving end. The Postal Telegraph Company had several Rowland circuits in operation, but they finally abandoned them because of the interference of its high frequency line signal.

There are no Rowland circuits in operation in this country today, though it is said they still operate a Rowland circuit in Italy.

After the Rowland system the Postal tried out the Wright system and equipped several circuits with it. It was foredoomed to failure, however, as its line signal employed positive, negative and zero intervals.

The inventor of this system had been a successful stock ticker inventor and his printer was built along these lines, through it printed on a page. The printer unit itself gave fairly good service, but under adverse weather conditions, it was practically impossible to secure good operation because of the zero intervals in the line signal.

The Wright system also employed direct keyboard transmission.

The Morkrum System was placed in commercial operation in 1910 and the first installation was made with the Postal Telegraph Company, between Boston and New York.

This was a direct keyboard page printing system, the signalling code being the five unit code employing only positive and negative intervals. It was operated at a speed of 60 words per minute, which gave an interchange of 120 words per minute over the wire, as it was operated duplex.

There was no continuous synchronism and the keyboard was what is known as a free keyboard. That is, it did not have to be operated in cadence with the transmitting mechanism. When a key was struck this started the operation of the transmitter which sent over the line a start impulse immediately followed by the five unit code combination. The start impulse would start the operation of the receiving mechanism for the reception of the letter signal. At the completion of the letter signal the proper polarity was held on the line to maintain the receiving mechanism in rest position until the depression of the next key.

As unison was maintained only for each single revolution, the speeds of the transmitter and the receiver need be only approximately the same.

While the line signal is referred to as five unit signal, because of the addition of the start pulse and the stop pulse, it is really a seven unit signal. This is true of all start stop systems, which followed this early Morkrum system.

When operating at a speed of 60 words per minute, the line frequency of this Morkrum system was about 25 cycles.

A direct keyboard system of this character had many operating advantages. With direct keyboard transmission and page printing reception the transmitting and receiving delays of the Wheatstone and similar systems were obviated. It was an ideal system for flash service with as direct communication between sender and receiver as a Morse duplex.

However, while proficient keyboard operators could exceed the speed of the fastest Morse operator, still the operator could not work at maximum efficiency on account of the speed limitation of the keyboard.

Many automatic operators can easily maintain an average speed of over 60 words per minute. But this is an average of speeds from perhaps 40 to over 100 words per minute. With a direct keyboard set at a maximum speed of 60 words per minute, there would frequently be times when the operator would drop below this speed, but she could never exceed it. Consequently, her average speed would be considerably less than 60 words per minute. With the tape perforator an operator can write at her maximum speed as the perforator is capable of speeds far in excess of 100 words per minute.

The next step in Morkrum development was to adopt tape transmission, but to eliminate the objectionable features of this method. To accomplish this, the apparatus was so arranged that the tape perforator was adjacent to the transmitter and an automatic feeding device caused the transmission of each letter only a few seconds after it was perforated.

By this arrangement with the transmitter speed set at 60 words per minute, an operator could easily keep the average speed of printing very close to the maximum, for when the speed of perforation exceeded 60 words a minute, this excess appeared as slack tape which was used up when the speed of perforation would drop below the speed of transmission.

The carrying capacity of this system with tape transmission proved to be from 15 to 20 per cent greater than with direct keyboard transmission.

There is also another advantage to tape transmission which effects a considerable saving and makes for smoother operation. It is the practice of the telegraph company to allow no corrections in received messages which are to be delivered. Now keyboard operators, in common with typists, occasionally will strike a wrong key. They are generally conscious of this as soon as it is done, but with direct keyboard transmission, the wrong letter has already been transmitted over the line and printed at the receiving station. With tape transmission, there is a little time between the striking of the keys and the transmission of the corresponding letter. When the operator makes one of these conscious errors, she can move the tape back and blot it out and no indication of this blot-out will appear on the printed copy at the receiving station.

While the transmission speed of the tape system just described was only 25 cycles for a speed of 60 words per minute, many of the wires on which it was operated, were capable of speeds of 35 to 45 cycles. Of course, if the load between two points justified it, the higher speed possibility of the wire could be utilized by speeding up the transmission, but it would be very hard to construct a printer which would operate at speeds from 80 to 100 words per minute without excessive maintenance.

Assuming that this could be done, however, there are other objections to the method. It would be necessary to have two perforator operators to prepare the tapes and a third operator to feed them into the transmitter. At the receiving station, it would be necessary to have an operator merely to remove the messages from the machine and one other or perhaps two others to check them.

The receiving speed would be so high that it would be impossible for the receiving operator to check any errors as the messages was being printed, so that there would be an additional delay to any message which contained an error.

Thus, to increase our speed from 60 words per minute to 100 words per minute, an increase of 66 per cent, we have increased our operating force 300 per cent. While this might be justified at times by the high investment charges of the wire, still we have introduced objectionable traffic delays.

As the Western Union Telegraph Company had tremendous loads between many points, they wished to utilize the capacity of their wires to the fullest possible extent. Therefore, about 1913, they started the development of their Multiplex system. They called upon Mr. Donald Murray, who has been mentioned as an ardent advocate of the five units code, and who since his work with the Postal, had done a great deal of work in the development of an improved Baudot Multiplex.

The clock train drive of the Baudot was very heavy and bulky and the governor an extremely sensitive mechanism. In the early days there had been attempts to substitute a phonic wheel drive for this, but apparently nothing had come of them. Murray did this successfully and secured a drive which gave very uniform speeds. Working in conjunction with the Western Union, and Western Electric engineers, a very beautiful Multiplex system was evolved. Several novel features, which facilitated handling, were embodied in the system.

In order to get the maximum capacity from their wires, they eliminated the extra correction pulses of the Baudot and secured correction from the letter signals themselves. This method was first used by Picard, many years ago, in working a Baudot circuit over a submarine cable between France and Algiers. The Western Union applied this principle in an improved fashion and secured a saving of about 9 per cent line time, resulting in higher possible speeds.

This Western Union multiplex system uses tape perforators with automatic

transmission and automatic signalling devices for signal communication between the receiver and the sender, for advising of errors, etc., without interfering with the normal transmission. Page printers are employed for reception.

They have two, three and four channel installations and have secured speeds in excess of 50 words per minute on some four channel circuits. At 50 words per minute per channel they secure an interchange of 800 words per minute over the wire, as they operate duplex. This same wire, operated duplex Morse would not yield more than 80 words per minute, or with single channel printer operation, 120 words per minute.

Of course, every circuit does not have the load to justify Multiplex operation. For the lighter circuits single channel Morkrums are employed and circuits that will not justify this system are worked Morse. It is interesting to note that in spite of the widespread use of printing telegraphs, that the traffic increase has been so great during the past few years that the demand for Morse operators is greater than ever.

However, future growth can be taken care of and the efficiency of handling traffic increased if a printing telegraph, suitable for even the lightest lines, is developed.

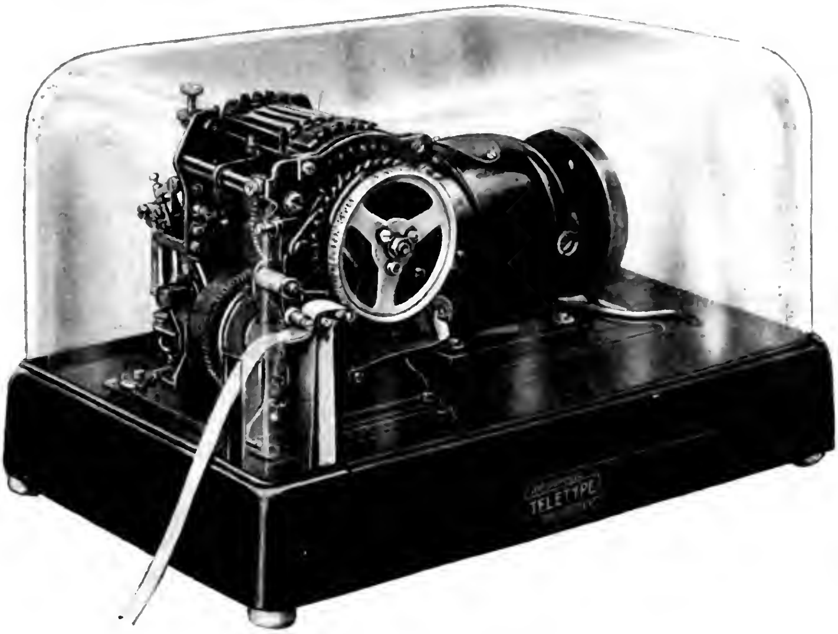


FIG. 15. Receiving Teletype.

With this aim in view the Morkrum Company has developed a printing telegraph which will operate on the standard five-unit code but which is so simple that it can be used at stations which handle as little as fifty messages per day. It can be maintained at outlying points by periodical visits of an inspector.

No. 15. Receiving Teletype.

In view of the remarkable record of service of the printing unit of the Baudot system, it was decided to adopt a similar mechanism for the printing portion of this machine. This means, of course, printing on a tape and the consequent gumming of the tape to the message blank, but investigation has proven that this operation is not nearly as complicated as it sounds and an operator can gum the tape as fast as it is received so that no consequent delay is introduced.

There is also a considerable saving in line time with a tape printer, for which page printing the code combinations for feeding up the paper and return-

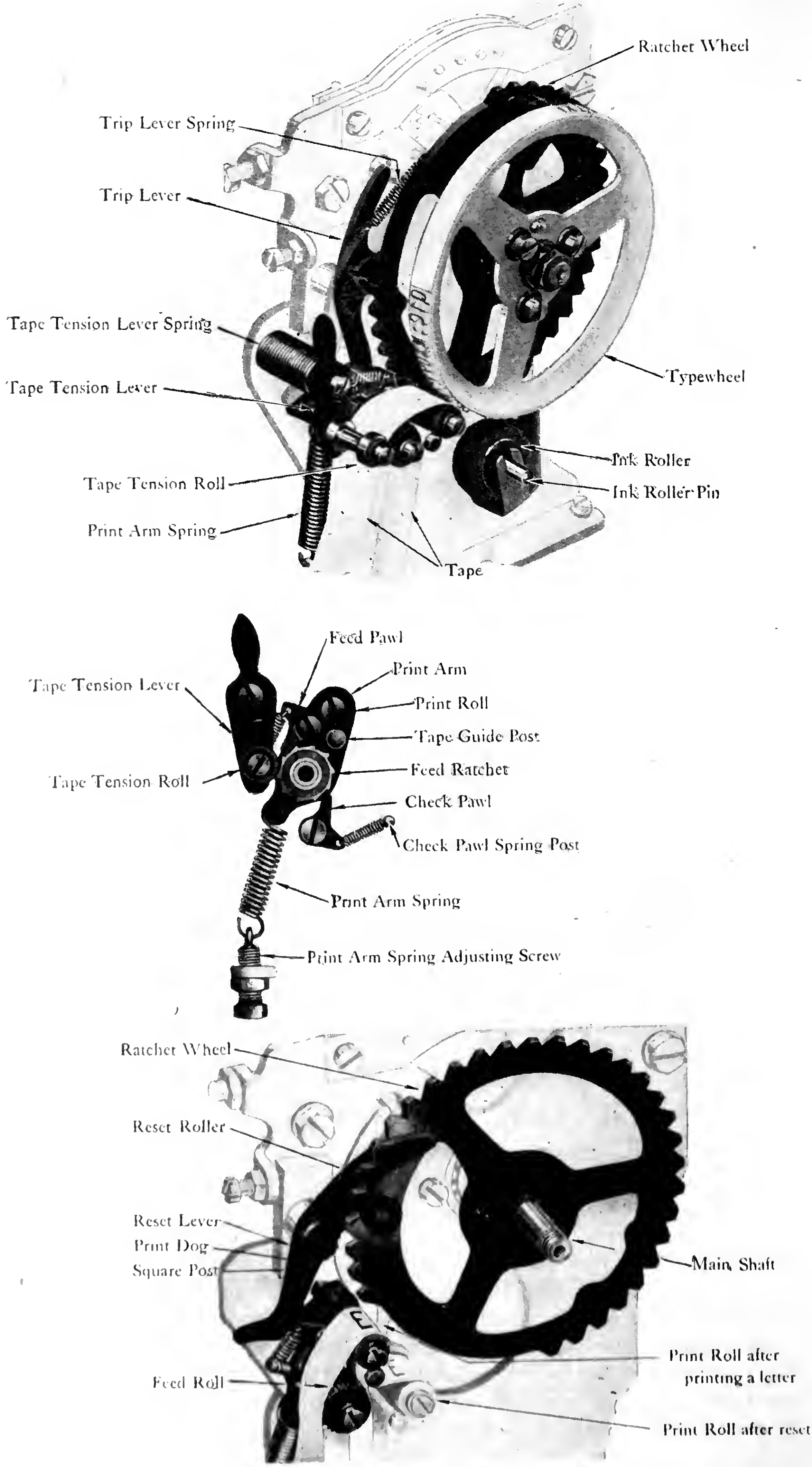


FIG. 16. Showing How a Letter is Printed.

ing the carriage, comprise an appreciable percentage of the characters transmitted for the printing of a message. Such signals are, of course, unnecessary with page printing.

The tape printer is infinitely simpler than a page printer. In fact, a tape printer of the Baudot class has only about one-tenth as many parts as a page printer. This is partly because the page printer has to perform two distinctly different classes of operation. The first is to print the characters, the second is to perform the various typewriter functions of moving the carriage for spacing, feeding up the paper, returning the carriage to start a new line, and shifting for upper case characters, etc. These functions complicate the mechanism considerably and as either the paper or the printing element has to be moved along to print the characters at different points on the line, the printer is apt to be rather bulky.

With a type wheel tape printer of the Baudot class it is merely necessary to release the printing arm at the time determined by the particular code combination to secure printing or spacing or shifting.

Figure 16 shows how a letter is printed. You will note that the tape passes around a printing roller below the type wheel. Behind the type wheel is a notch corresponding to each letter on the type wheel. It is merely necessary to release the arm carrying the print roll at the proper time and the spring will cause the pointed end or "print dog" to fly up and engage a notch in the ratchet. As this ratchet is revolving with the type wheel, the print roll with the tape will roll over the face of the corresponding letter.

As the tape passes from the print roll, it passes over a feed roll against which it is pressed by a tension roll. The feed roll is attached to a ratchet at its rear end and as the print arm is thrown out of engagement with the ratchet wheel and assumes a vertical position of feed pawl engages a tooth of the ratchet and moves the feed roll and the tape.

Now as the type wheel and ratchet revolve farther, a reset roller on the back of the ratchet wheel strikes the upper end of a reset lever. The lower end of this lever strikes the print arm and moves it back to the horizontal position where it latches again with the trip lever. A certain portion of the type wheel has no letters on the rim and a corresponding portion of the ratchet wheel has the teeth cut away. It is while these are passing the print arm that it is reset.

Figure 17 shows how the print arm is tripped at the proper place. There are five selectors or seekers which are bent up metal pieces, each having a toe which presses on the rim of a notched combiner wheel. The upper portions or heads of the seekers are in contact with each other. A spring attached to a tension lever on the left presses the heads of the seekers to the right, since the heads of the seekers are all in contact, the tension lever cannot rotate on its shaft unless all of the seekers move. Such a movement can only take place when there is a notch beneath each of the five toes at the same instant.

The lower portion of Figure 17 shows the seekers when they have each dropped in a notch at the same instant. This allows the tension lever to move and its horizontal extension strikes the upper end of the trip lever which causes the lower end to disengage the print arm.

Figure 18 shows a different view of the combiner wheel. It is made up of two notched discs. Note that where there is a notch in the front disc there is a corresponding smooth place on the rear disc. There is a separator plate between the two discs which prevents the seekers from passing from one disc to the other except at one point. By moving some of the seekers to the front disc

and leaving the rest on the rear disc, the print arm can be tripped at thirty-one different places according to the different settings of the seekers.

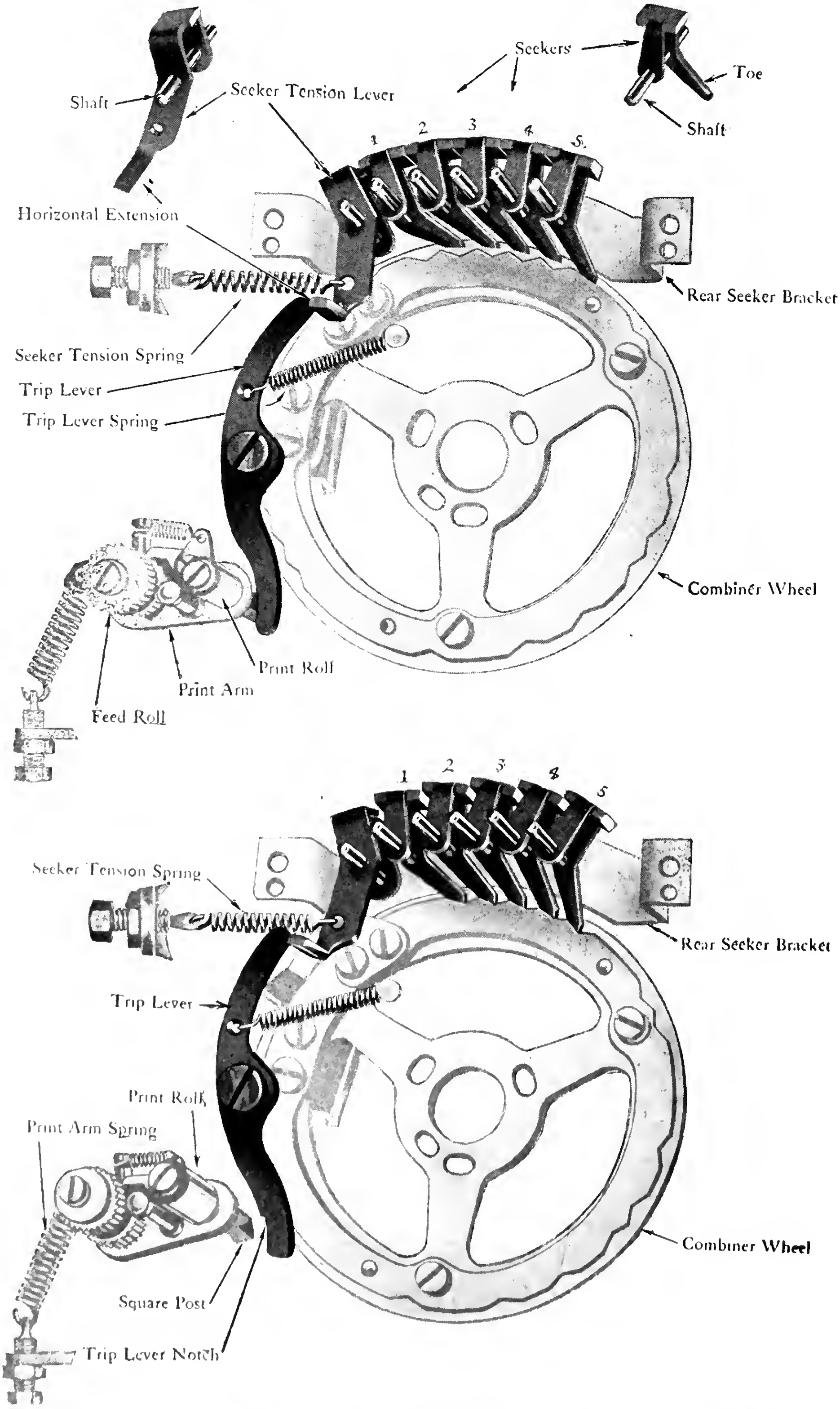


FIG. 17. Showing How the Print Arm is Tripped at the Proper Place.

Figure 19 illustrates how the received signals control the setting of the seekers. The shuttle is a metal tube on the main shaft which can slide backward or forward. A spring normally presses it toward the rear. A roller on the side of the shuttle is pressed against a cam ring which has five cuts or indents. At the

bottom of each indent a pin projects through the cam ring and the rear end of the pin is against the lower end of a selector lever.

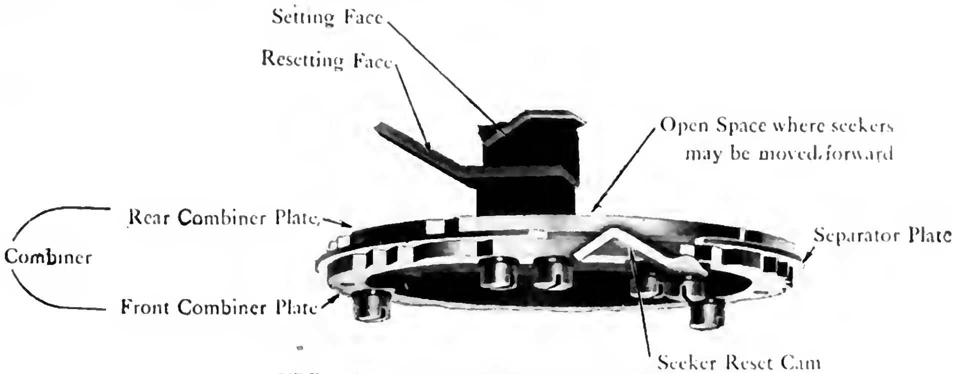


FIG. 18. View of Combiner Wheel.

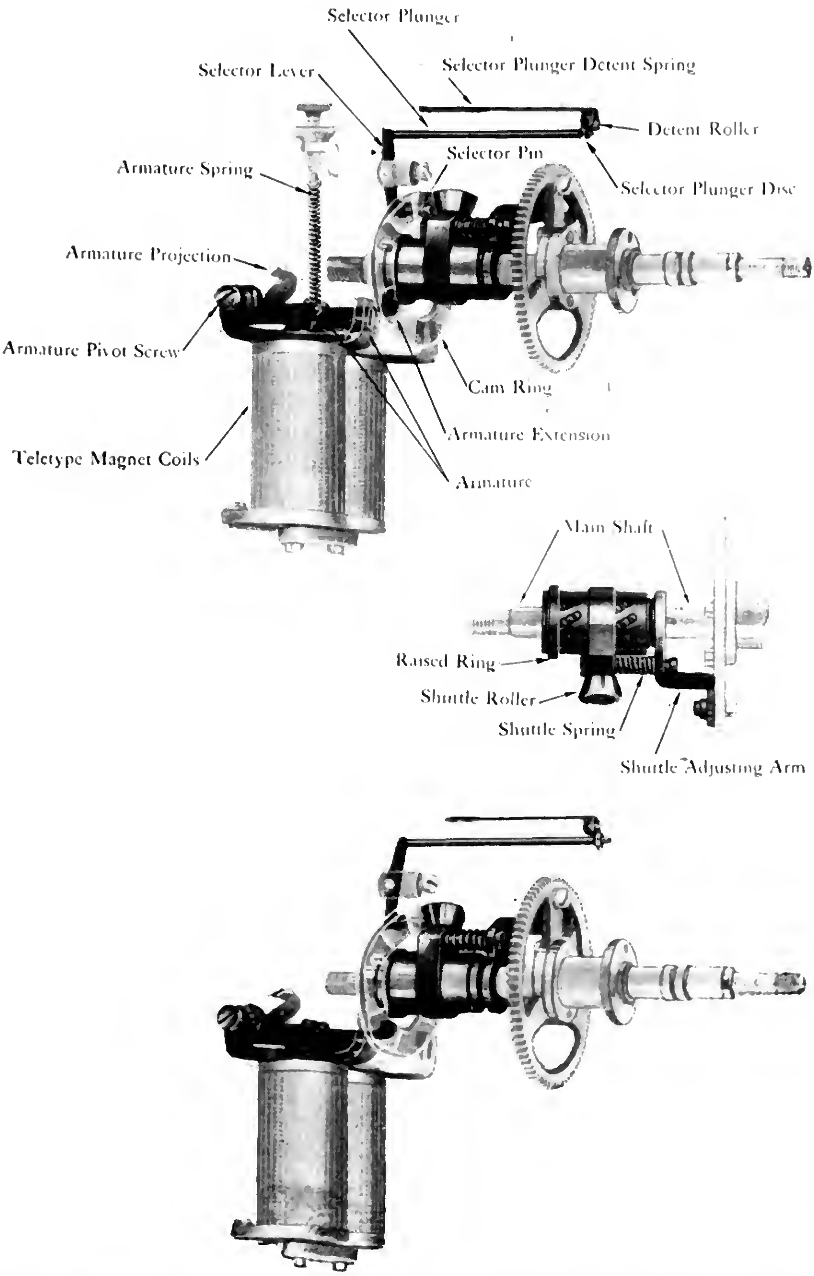


FIG. 19. Illustrating How the Received Signals Control the Setting of the Seekers.

If the shuttle roller drops into an indent, this pin will be moved backward and press the upper end of the selector lever forward, pushing the selector plunger forward.

Whether the shuttle roller will drop into an indent is determined by the position of the magnet armature at that instant. As the magnet is energized or de-energized according to the code combinations, the armature is pulled downward by the magnet or upward by the spring. If when the shuttle roller passes off the high part of the cam the armature is up, the raised ring of the shuttle will strike the armature extension and the roller will be held out of the indent.

This condition is shown in the upper portion of Figure 19. However, if the armature is down when the roller passes off the high part of the cam ring, the roller will drop in the indent and set the corresponding selector plunger.

Figure 20 shows how the moving forward of the selector plungers will move the corresponding seekers to the front combiner disc. The first, third and fifth plungers have been moved forward. As the setting face of the selector cam moves along it will grasp the discs on the ends of the plungers and move the plungers forward against the seeker shafts, causing the corresponding seekers to move to the front disc. As the resetting face of the selector cam (Figure 21) passes in front of the selector plungers it strikes the plunger discs and sets the plunger back in normal position.

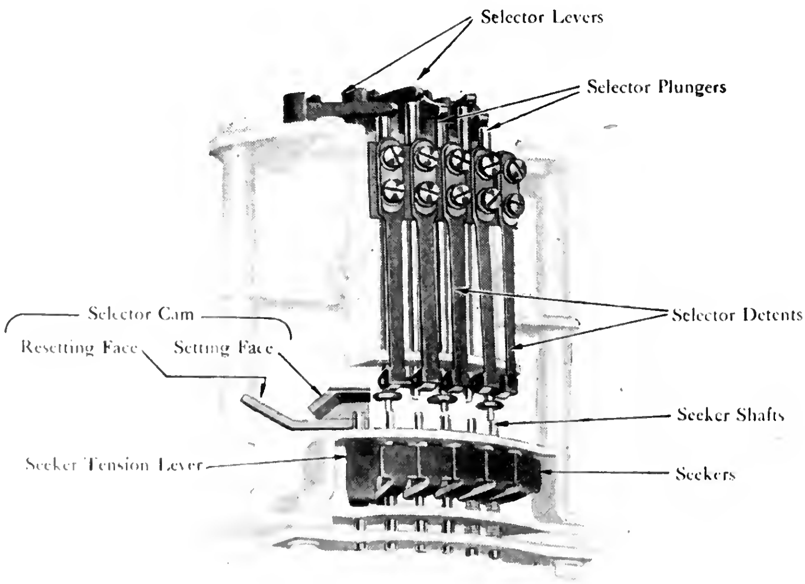


FIG. 20. Shows How the Moving Forward of the Selector Plungers Will Move the Corresponding Seekers to the Front Combiner Disc.

The question of suitable power for page printer operation is frequently an annoyance, as 110 volts D. C. is required and several amperes of it. In case suitable direct current is not available, it is necessary to install a motor generator set.

With this tape printer which we call the teletype, the only direct current necessary is for the operation of its one magnet. It can be operated from any source of direct current from 12 volts up. This current could be secured from batteries or transmitted from a distance. Of course, it is possible that the situation would require a motor generator set but it would be very much smaller than one necessary for page printer operation.

While the teletype can be operated from tape transmission, a direct keyboard transmitter of very simple construction has been designed for lightly loaded circuits. This keyboard transmitter is driven by the same motor which drives the printing mechanism.

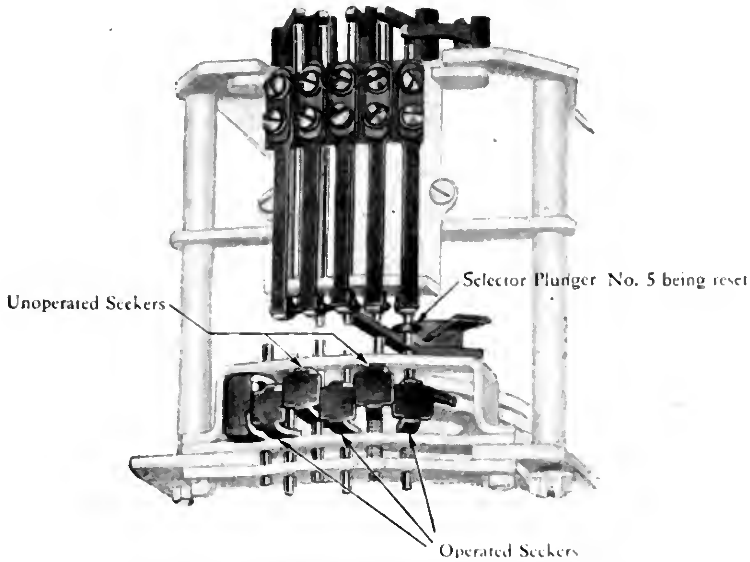


FIG. 21. Resetting Face of Selector Cam.

Figure 22 shows the teletype mounted on the keyboard transmitter. The transmitter is seen at the right. There are six contacts, one start and five selective. Six cams which make on revolution for each letter control these contacts and either open or close the selective contacts at the proper time during the revolution according to the key which has been depressed.

FIG. 22. Teletype Mounted on Keyboard Transmitter.

It is believed that this simple machine will find a field outside of the regular telegraph service for inter-communication between the units of large merchandising and industrial concerns.

The power for performing the various printing functions of the teletype is provided by a 1-40 horse-power motor and motors can be supplied for operation on either direct or alternating current.

I believe that the advantages of a simple tape printer outweigh any possible objections to pasted messages and the time will come when the bulk of the telegraph traffic of the country will be handled by tape printers. In France, where the Baudot has been used for years, they steadfastly refuse to be converted to page printing.

The modern printing telegraph systems have been considered from the message traffic standpoint. Press traffic presents different problems requiring different apparatus or different methods. While printing telegraphs have come into general use for handling press, a great deal of engineering work has yet to be done to render their application to this service more efficient and economical.

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TECHNICAL PAPERS

The Influence of Commodity Price Movement Upon Public Utility Valuations.

By H. R. ALLENSWORTH.*

Presented, December 9, 1920

INTRODUCTORY.

A Public Utility enterprise, meaning in accordance with the usual acceptance of the term an enterprise engaged in the business of supplying a public utility service, which enterprise is ordinarily owned by corporately organized individual investors, partakes of the characteristics of both public and private business enterprise and hence becomes Quasi Public. Accordingly, in any proceedings involving the evaluation of the property of a Public Utility enterprise for the purpose of determining fixed capital charges in cases where rates of charge for Public Utility Service are in question, the interests of the Public and the Public Utility are inseparably interwoven and interdependent.

That neither the Public nor the Public Utility can be successfully outraged or exploited to the permanent advantage or profit of the other is a truism which seemingly, in view of the present-day knowledge of the subject, should be accepted without question. The Public and the Public Utility encounter in all such procedure the problem, common to both, of determining the property value or equitable amount upon which the Public Utility enterprise is entitled to earn a return and the equitable rates chargeable to the Public for Public Utility service. An inequitable adjudication of property values or rates of charge results in the violation of the property rights of either the Public or the Public Utility.

In view of the elaborate system of safeguards, both constitutional and statutory, established for the protection of property rights, it is truly amazing to witness the perfunctory manner in which these rights are defended in most all cases involving the evaluation of Public Utility property. Public Utility agents especially, in most cases it seems, are inclined to defend the property rights of the enterprise in a most prfunctory manner and accept in behalf of the enterprise with seeming indifference, valuations of Public Utility properties and rates of charge for Public Utility service which violate the property rights of the enterprise in a manner most flagrant. Apparently, the agents of both interests, are inclined to ignore the fact that to avoid violation of the property rights of either the Public or the Public Utility the entire procedure of evaluation and rate making must be based upon sound economic principles.

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Equitable valuations of Public Utility properties and equitable rates of charge for Public Utility service will not obtain until the basic economic principles underlying the whole subject of property value are accorded the most attentive consideration by the agents of both the Public and the Public Utilities. The evaluation of the property rights of any Public Utility enterprise for the purpose of determining fixed capital charges in cases where rates of charge for Public Utility service are in question, is not a matter of engineering nor is it a matter of accountancy. Evaluation in such cases, in the last analysis, is a matter of applied economics and the legal protection of property rights, although applied economics as pertaining to the evaluation of Public Utility property necessarily embraces engineering and accountancy; only however, insofar as these subjects may become the means to an objective.

The exchange value or purchasing power of the monetary unit, the dollar, undergoes change in response to the influence of economic conditions. Accordingly, the dollar is not a unit of absolute value. The evaluation of the property of any Public Utility enterprise necessarily requires the expression of invested wealth in terms of the monetary unit. A given quantity of invested wealth when and as expressed in terms of money, varies as to amount with the varying value of the dollar. Consequently, to fulfill the requirement of expressing invested wealth, or that amount of wealth dedicated by a Public Utility enterprise to the use, convenience and service of the public, in terms of the monetary unit; the monetary unit must be interpreted in terms of value as of the date of consideration. A proper interpretation of the monetary unit in terms of value as of a date certain can result only from an intelligent interpretation of basic economic principles.

Assuming a proper interpretation and application of the Reproduction Theory, a statement of the amount of invested wealth dedicated by a Public Utility enterprise to the use, convenience and service of the public as of a date certain in terms of value in accordance with basic economic principles constitutes a statement of the property value of that enterprise or the amount upon which the enterprise is entitled to earn a return as of the date of consideration. Corollary to this, we have the following definition of Public Utility property value as established in valuations for the purpose of determining fixed capital charges in cases where rates of charge for Public Utility service are in question, i. e., that amount upon which the enterprise is entitled to earn a return as determined by a proper application of the Reproduction Theory interpreted in accordance with basis economic principles or that amount of invested wealth dedicated by the enterprise to the use, convenience and service of the Public when and as expressed in terms of the monetary unit interpreted in terms of value as of the date of consideration.

The interpretation of economic principles in the determination of the property value of Public Utility Enterprise; also, the application of the principles as interpreted together with the results of such application in the evaluation of a large Public Utility Enterprise are set forth in the following discussion.

GENERAL.

The rise and fall of commodity prices, especially major price movement, has ever been an attractive field for study and speculation. Major movement of commodity prices has been made the subject of searching inquiry and profound study by both classical and political economists for perhaps hundreds of years. As a result of the time and effort devoted to this subject by economists and other

competent investigators a considerable amount of dependable information pertaining to commodity price movement has been gleaned. There has resulted, however, not one preventative or remedial measure, contrived for the promotion of financial and industrial welfare and the economic welfare of the individual, of more than transitory effect. Also, there has resulted but very little agreeable information on the subject of value. Moreover, the very important question as to what extent commodity price movement may influence value, as expressed in terms of monetary units, in the evaluation of public utility properties, especially in valuations for the purpose of establishing fixed capital charges in cases where rates of charge for public utility service may be in question, seems to have been heretofore accorded especial neglect. This is true also regarding the correlative question as to the amount of consideration that should be extended commodity price movement as indicative of the relative worth of the monetary unit in the determination of fair rates of charge for public utility service. Thus, with extended inquiry it becomes increasingly clear that despite the fund of dependable information available to those investigating the subject, the problems associated with commodity price movement with all their ramifications throughout the realms of economics, finance, industry and politics, remain unsolved to a very great extent.

The subject of rising prices and especially the present high level of commodity prices, together with the economic and political problems resulting therefrom, of which the present high price of living is but an episode, constitutes the greatest, the most momentous economic question yet presented for the contemplation of man. The question of price movement involves every problem in the realm of finance and industry. Its factors are great in number and import and their seemingly limitless and varied combinations create a perplexity truly amazing.

High prices are neither better nor worse than low prices in the welfare of industry and the economic welfare of the individual, assuming financial and industrial conditions to have adjusted themselves to a given price level. The welfare of industry and the economic welfare of the individual is impaired by *price movement;* either upward or downward. During periods of declining prices losses occur throughout the realm of industry. Salary and wage earners are deprived of employment, business becomes stagnated and losses occur to all. During periods of rising prices salaries and wages are reduced in purchasing power, and are thus rendered inadequate to meet the corresponding increased price of living. During periods of rising prices all forms of fixed income are lessened in worth. Trust funds, philanthropic foundations, endowments for hospitals, universities, etc., suffer a reduction in the value of the principal and the income to the beneficiaries suffers a reduction in worth. All forms of deferred payment contracts are lessened in value. All evidences of indebtedness, such as bonds, debentures, notes, etc., are lessened in value and the income therefrom suffers a reduction in worth. During periods of rising prices investments in public utility properties are lessened in value, income from operation is reduced in purchasing power and operating expense is increased, all of which tends towards rendering the business insolvent. Thus major movements of commodity prices whether upward or downward, result in absorbing capital and reducing income either in amount or worth, or both.

This country has experienced two major price movements during the last fifty-five years. From the period 1864 to 1893-96 the commodity price movement was downward. From 1893-96 to the present time the movement of prices has been pronouncedly upward, at a constantly increasing rate, to the

present high level. During the downward movement from 1864 to 1893-96 commodity prices were gradually falling below the cost of production and it was the producers; especially the rural people, the populist, the granger and the herder, to complain. With the upward movement of commodity prices from 1893-96 to date it has been the city people to complain, a vast majority being dependent upon a fixed income of some form or other, and most vehement has been their protestations against the high price of commodities with the attendant high price of living.

The movement of commodity prices either upward or downward promotes a very great portion of the people of the nation to immediate alarm and they become most insistent in their demands upon the government for relief from the effect of economic forces over which the individual has no control. Largely in response to such demands and for other reasons, patriotic in some instances, public authority has, from time to time, exerted an honest effort, by the enactment of legislative measures, to "Restore Prosperity" during periods of declining prices or "Reduce the High Cost of Living" during periods of rising prices. Also, contemporaneous with every agitation for economic reform the ubiquitious political trickster has made his bid for patronage by flaunting panaceas guaranteed to cure all economic ills. The result being further confusion in the minds of the world of business and the public generally as to the underlying causes of price movement.

Within the last three decades this country has been agitated from time to time by many suggested economic reforms. "Free Silver," "Protective Tariff," "Trust Busting," "Banking Reform," "Regulation," and others, each guaranteed by its proponents and adherents to satisfactorily adjust economic conditions; "Restore Prosperity" or "Reduce the Cost of Living," whichever happened to be the need of the hour. Thus far there have not been enacted by either National or State Legislative Bodies, preventative or curative measures that have resulted in any lasting benefits. The usual result of all legislative measures thus far enacted for the purpose of stabilizing economic conditions has been, in the attempt to remedy certain evils, to bring into evidence other evils of equal or greater force. In retrospect it seems that heretofore suggested and attempted economic reforms have been basd upon the phantoms of some prevailing fancy engendered by temporizing expediency and current sentiment rather than upon profound convictions originating procreated from basic principles.

An adequate concept of the cause and effect of price movement can result only from the fullest recognition of the fact that commodity price movements are manifestations of certain phases of a most complex economic system yielding to the aggregate influence of many complex and variable economic forces and that economic forces follow certain well defined laws or principles. The operation of economic forces in many cases is as absolute as the law of gravitation. The laws or principles governing these forces are not ruled or swayed by civil or ethical standards of man made laws of the body politic. Further, they can neither be abrogated or altered by public opinion, legislative enactments, judicial decree, or corporate policy.

Until the fullest recognition of these facts obtains throughout the realms of finance, industry and politics, the efforts of public authority directed towards finding the cause of, and relief from anamalous economic conditions as reflected by price movement will be of no avail. Attempts at price fixing will accomplish naught and discussion in congress and legislature, in pulpit and chair, and in forum and press will amount to so much persiflage.

Until the basic economic principles underlying the whole subject of price movement are accorded the most attentive consideration by those responsible for the management and operation of public utilities by Public Utility Commissions and by Courts of Law, the ever recurring question as to what may constitute fair rates of charge to the public for public utility service and what may constitute fair compensation to the public utility for supplying service, cannot be equitably disposed of.

That "Cost of Service" is of primary importance and must be accorded first consideration as a primary basis upon which fair rates of charge for public utility service may be established cannot reasonably be questioned; notwithstanding the fact that "Value of Service" and other criteria may become determining factors in specific cases, especially in the determination of class rates. The determination of the cost of public utility service necessarily involves inquiry into the value of that property dedicated to the use and convenience of the public. Value in such cases must necessarily be expressed in terms of the monetary unit. The basis of the dollar is fixed by statute in terms of one commodity only; i. e., gold. Consequently, in response to the influence of many complex and variable economic forces the purchasing value of the dollar as expressed in terms of commodities other than gold fluctuates. The price of commodities, excepting gold, and a few others in recent instances, is not fixed. Hence in response to the influence of economic forces the price of commodities as expressed in terms of the monetary unit fluctuates (exceptions as noted). The relative worths of commodities remain comparatively constant.

From this it becomes at once apparent that the evaluation of public utility properties for the purpose of etsablishing fixed capital charges in cases where rates of charge are in question, requires expression of the value of property, which value remains comparatively constant, in terms of dollars, the value of which is constantly changing. In other words, the evaluation of public utility properties for this purpose requires interpretation of the dollar in terms of value as of a date certain. A true statement of value can result from no other procedure.

The term "Fair value' has been accorded a certain degree of populairty in the language of courts and commissions in their decisions in valuation cases. An adequate definition of "Fair Value," however, seems to be lacking. Nevertheless, accepting the term for what it may mean, the question as to what may constitute so-called "Fair Value" in the determination of fair rates of charge for public utility service has in the past and up to the present time been made the subject of more or less contention before reviewing tribunals. The contestants in every case become involved in a maze of bewildering speculation, based upon chimerical assumptions, from which it is impossible to extract one scintilla of agreeable theory or argument in support of value. Price, cost and value are hopelessly confused and definitions become ambiguous.

The determination of the property value of public utility property for the purpose of establishing fixed capital charges in cases of inquiry as to the reasonableness of rates of charge for public utility service is not a matter of speculation nor is it a matter of opinion. A true statement of property value for this purpose can result only from the intelligent interpretation of economic principles. Property value when thus determined fulfills all requirements of so-called "Fair Value," "Rate," "Base Value," etc.

THE PREVAILING HIGH LEVEL OF COMMODITY PRICES.

That the prevailing high level of commodity prices is largely due to the distortion of economic conditions resulting from the recent world war is imme-

diately apparent. But while it is true that the recent world war has caused a most violent distortion of economic conditions which has naturally resulted in a most pronounced rise in the level of commodity prices, it is nevertheless true that the tendency of commodity prices has been upward since 1896. Moreover, the economic forces causing the upward tendency of commodity prices from the year 1896 to the year 1913 and the economic forces causing the sudden and pronounced rise of commodity prices during the period of the world war are generally the same; these forces obtaining, of course, to the most exaggerated degree during the latter period.

The principal causes of the rise in commodity prices to the prevailing high level are monetary causes which are manifest in the prevailing low purchasing power of the monetary unit. This is attested by the fact that countries of like monetary standards have like commodity price movements. The commodity price movements of gold standard countries show a remarkable resemblance as do also the commodity price movements of silver standard countries.

The average price (provided the average is taken over a sufficient period of time) of a specific commodity, as compared to a similar average price of some other commodity remains comparatively constant. This is well illustrated by the prices of the three basic industrial commodities, Copper, Pig Iron and Cotton. Referring to Plate 1: Thereon will be noted graphs of the average prices prevailing each year 1860-1918 inclusive for Copper, Pig Iron and Cotton. The Line "A" "B" through each of these graphs represents for the purpose of comparison the average price throughout the fifty-nine year period. From the three lines "A" "B" it is most patent that the average price, throughout the last twenty-five years of this period, for each one of these commodities has remained comparatively constant as compared with the same average prices of the other two. The average prices of all three commodities as expressed in terms of dollars, were however, decreasing from 1862 to 1893-96 and have been increasing from the period 1893-96 to the present time. This is found to be generally true of the prices of all commodities.

Further argument should be unnecessary to prove that taken on an average the worth of a commodity as measured in terms of other commodities remains comparatively constant (neglecting influence of the ratio of supply to demand) whereas, expressing commodity prices in terms of the monetary unit, price undergoes change with the changing purchasing power of the dollar. As a corollary of this; taken on an average, the relative worths of industrial commodities, when measured in terms of other industrial commodities, remain comparatively constant. Hence (neglecting the influence of the ratio of supply to demand), the present high level of commodity prices, in its final analysis, is but expression of the prices of commodities as measured by the monetary unit the purchasing power of which has been decreasing for the past quarter century. The question of determining the cause of the prevailing high level of commodity prices thus becomes that of determining the cause of the lessened purchasing power of the dollar as hereinbefore stated, is due principally to monetary causes; namely, currency inflation and credit expansion.

The more or less gradual inflation of currency and expansion of credit during the period from the year 1896 up to the financing of the recent world war was caused (directly or indirectly) by the increasing power of the business world to make its own money, due to the increasing use of credits of various forms; the increasing power of the business world to prevent panics and control depressions,

the increasing plentitude of gold for currency purposes, the decreasing necessity of gold for redemption purposes, the increasing plentitude of easy credit for business and speculative operation and the increasing deposits of surplus money as captal for credit. (Plate II.).

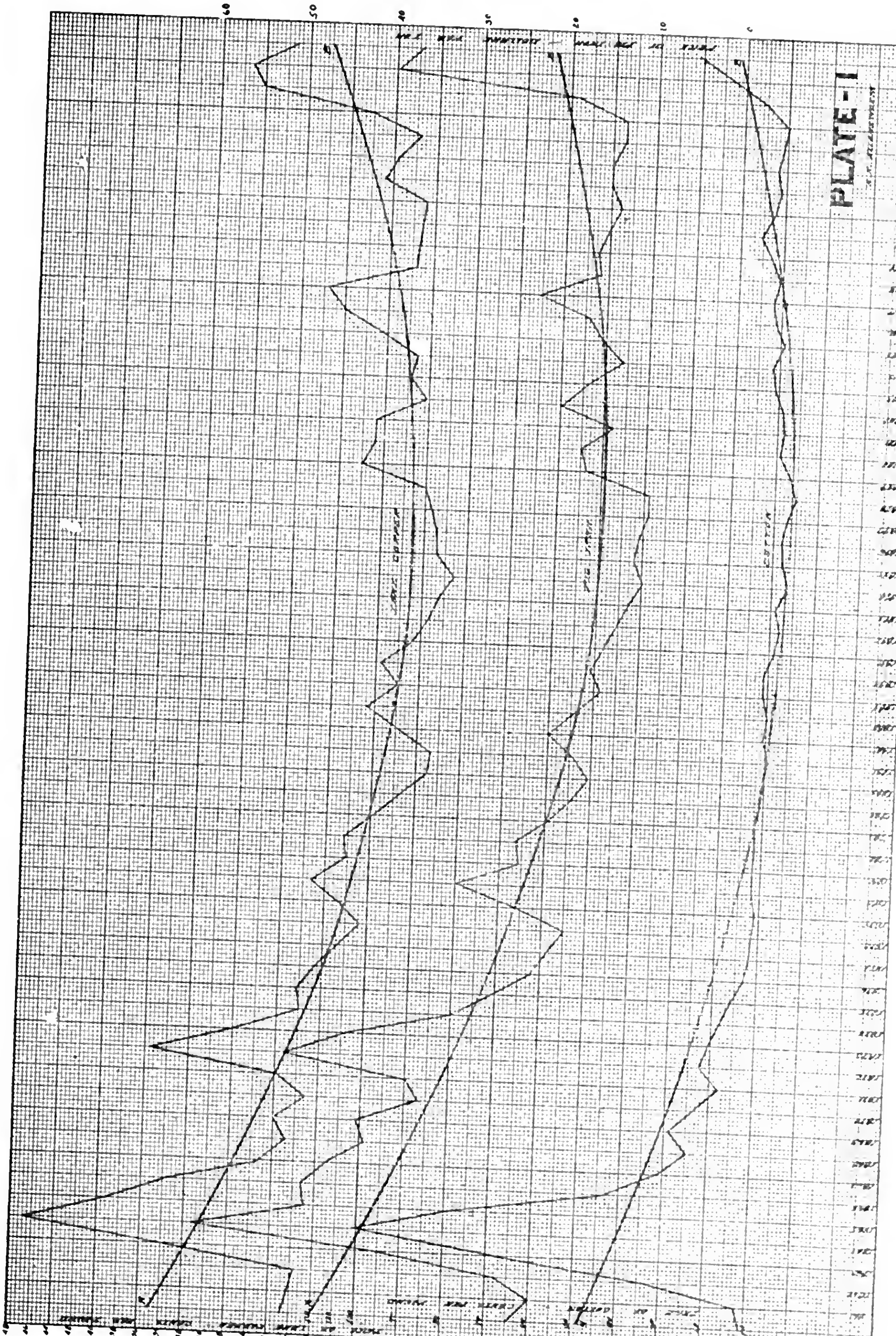

Plate I. Comparative average prices of copper, pig iron and cotton.

The world-wide inflation of currency and expansion of credit during the recent world war is, of course, directly attributable to the vitally urgent necessity of financing war materials purchases of unprecedented magnitude, mobilizing

and placing in the field perhaps the largest armed forces the world has ever known, the maintaining lines of communication to armies in the field, the most extensive in history.

The currency of the world (outside of Russia) increased from 1913 to 1918, two hundred and forty percent. The face value of this increase in currency, Mr. O. P. Austin has said, is equal to more than all the gold and all the silver mined throughout the world since the discovery of America. National debts of the world have increased from 1913 to 1919 four hundred and fifty percent. Bank deposits during the same period increased two hundred percent.

In the United States, money in circulation increased from 1.5 billions in 1896 to 3 billion 360 millions in 1913 and from this amount in 1913 to 5 billion 380 millions in 1918. An increase from 1896 to 1913 of one hundred and twenty-four percent and an increase from 1913 to 1918 of sixty percent; a total increase from 1896 to 1918 of two hundred and fifty-eight percent. Individual

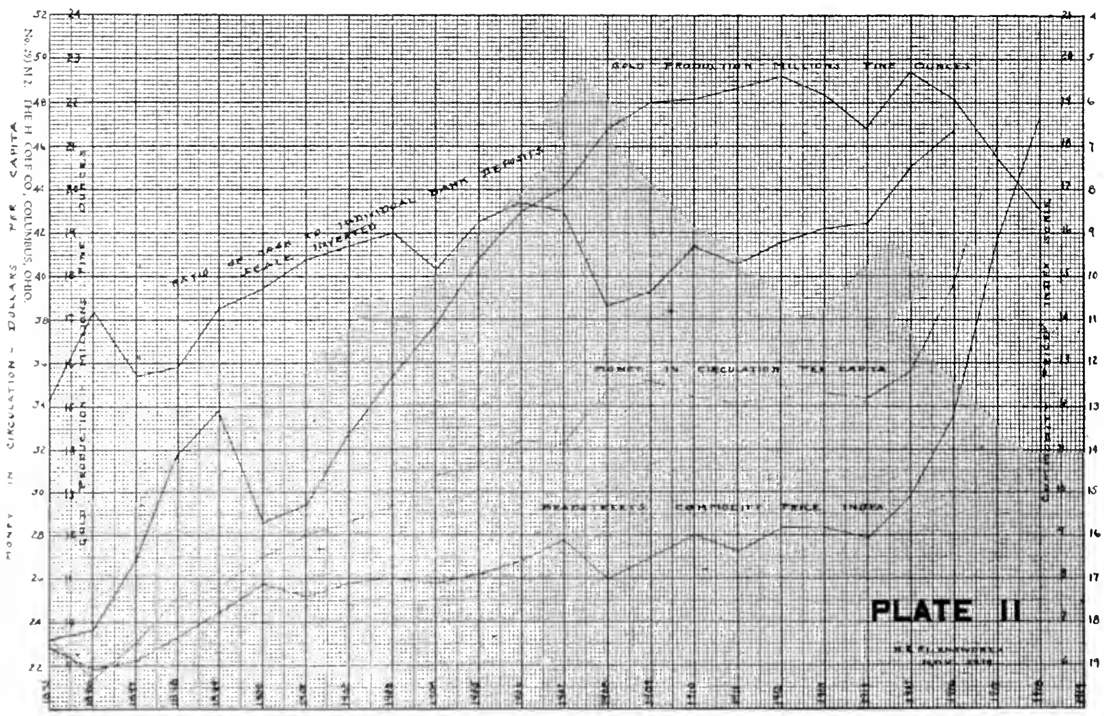

Plate II. Comparative commodity prices with money circulation.

bank deposits increased from 4 billion 950 millions in 1896 to 17.5 billions in 1913 and to 27 billion 800 millions in 1918. An increase from 1896 to 1913 of two hundred and fifty-three percent and an increase from 1913 to 1918 of fifty-nine percent; a total increase from 1896 to 1918 of three hundred and twelve percent.

It has been argued that the currency system of the United States is not inflated. In fact the Federal Reserve Board has stated that the expansion of Federal Reserve Notes is the result of and not the cause of high prices that Federal Reserve Notes grow only out of legitimate commercial transactions and are backed up by a forty percent minimum gold reserve. However, the security underlying the currency system is primarily the marketable wealth of the nation. Consequently, the amount of gold reserve underlying bank notes, separately considered, is no criterion as to the solvency of the currency system. Furthermore, when a transaction is made on inflated prices, whether there be forty or one hun-

dred percent of gold reserve behind the Federal Reserve Board by discounting the paper that grew out of transactions on an inflated basis, sanctions the outside existing inflation and the credit power of the nation is correspondingly expanded.

Accepting the general term credit power in its broadest sense it cannot be denied that the credit power of this country is expanded to an unprecedented extent and that the present expansion of the credit power of the nation is the cause of the existing low purchasing value of the dollar.

The inflation theory may perhaps be best expressed as follows: The purchasing value of the monetary unit at a given time is determined by the ratio of total credit outstanding (currency in circulation and bank deposits) to the amount of marketable wealth. A decrease in amount of marketable wealth or an increase in amount of credit outstanding causes relative inflation of the monetary unit with consequent diminished purchasing power. The production of marketable wealth limits the increase in national wealth and the nation's income. Increasing

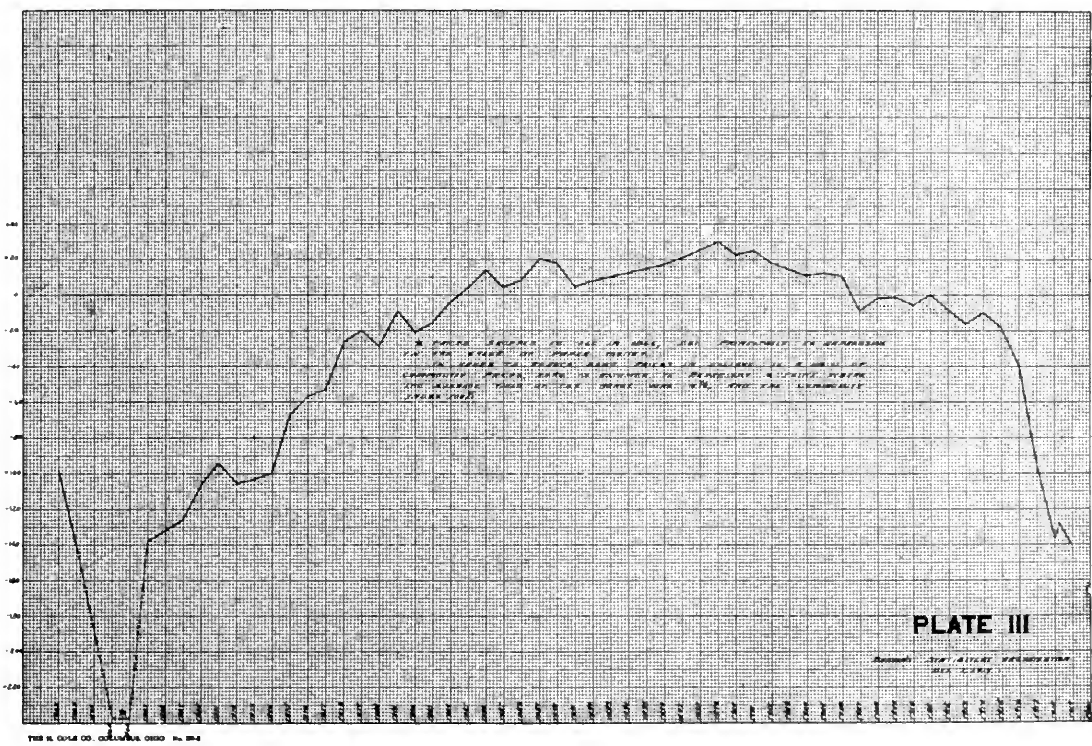

Plate III. Bond values expressed in terms of commodities.

the amount of currency in circulation will not unlock Nature's store houses of riches nor will an increase in the velocity of money circulation through credit expansion.

The dollar has declined in purchasing value since 1896, and especially under the necessities of war financing, because expansion of the credit power of the nation has proceeded at a rate exceeding the increase in realizable wealth. The restoration of the purchasing value of the dollar to the basis prevailing in 1913-14 can be accomplished in either one of two ways; increasing production or contracting credit power. Increasing production sufficiently to overcome the existing credit expansion will for various reasons probably not be accomplished to any appreciable extent. Contraction of credit power to an appreciable extent within the next few years seems to be highly improbable because of the impracticability of rapidly contracting the enormous credits outstanding as a result of war financing. While it is quite possible that the existing war credits will be grad-

ually withdrawn, due cognizance must be accorded the fact that the large issues of war securities will be more and more used as a basis for corporate and individual loans so that the increasing use of credits from this one source alone will probably offset to a considerable degree what would otherwise be a normal and gradual reduction of outstanding credit.

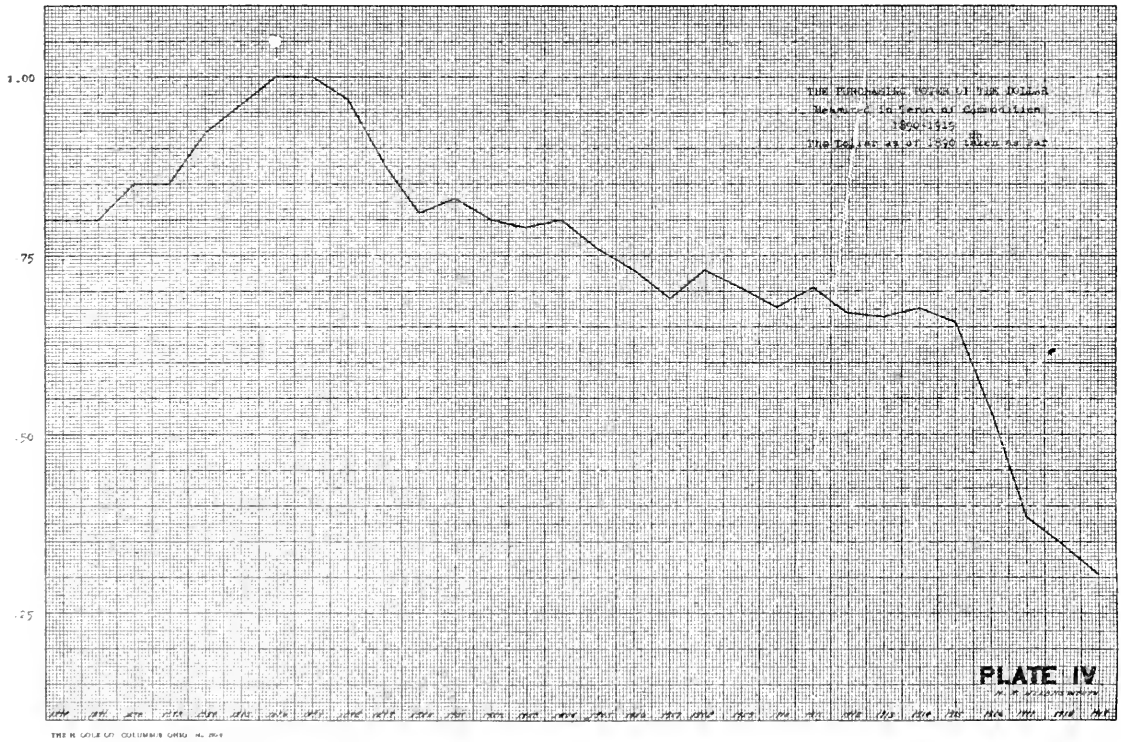

Plate IV. Purchasing power of the dollar, Par 1896.

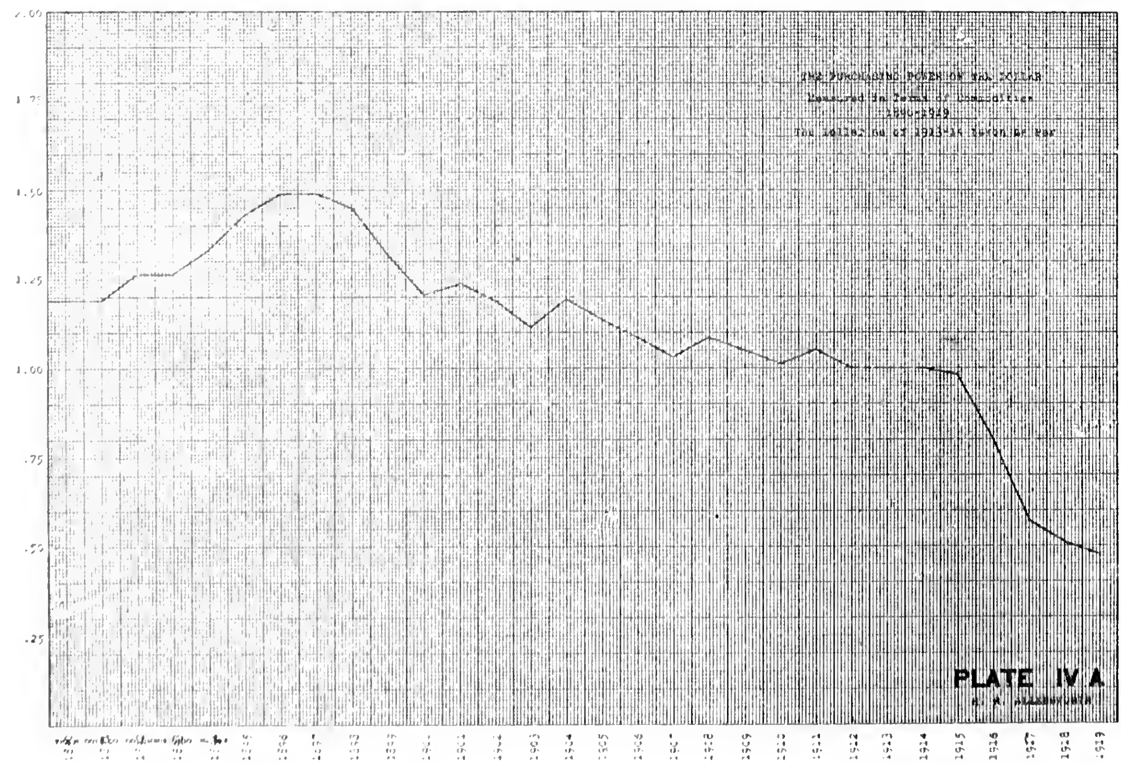

Plate IVA. Purchasing power of the dollar, Par 1913-14.

These and other factors indicate that the present high level of commodity prices will prevail for at least several years to come unless existing conditions are greatly changed by some violent economic disturbance.

The effect of the prevailing high level of commodity prices on long term investments and fixed incomes with commodity price movement is cogently illustrated by the change in the value of bonds with commodity price movement as shown by the graph "Plate III". Ordinarily in the sealms of finance and business bond values are thought of and expressed in terms of dollars. The real value of bonds is however best expressed in terms of an equivalent amount of useful goods. On "Plate III" Bond values expressed in terms of commodities are shown for each year 1862-1918 inclusive. This graph shows that in 1914 a $1,000,000 bond selling at par would buy a given amount of living necessities. According to price statistics, the same bond in 1919 would buy only about half as much as it would five years previous.

The decreasing purchasing power of the dollar from 1896 to 1919 is forcibly illustrated by the Graph "Plate IV.".

This graph reveals the purchasing power of the dollar as measured in terms of the average wholesale price of all commodities, the purchasing power of the dollar as of 1896 being taken as unity.

From this it is seen that the purchasing power of the dollar as of 1918 was only one-third of what it was in 1896 or stated conversely the dollar depreciated in purchasing power sixty-six percent from 1896 to 1918.

Losses accruing because of this depreciation in the purchasing power of the dollar are colossal. Professor Irving Fisher has estimated that from 1896 to the end of the world war the shrinkage in the purchasing power of world moneys has been a hundred billion dollars. The shrinkage in the purchasing power of the dollar from 1896 to date has produced losses of proportional amount.

The losses are trust funds, philanthropic foundations, endowments, etc., those holding promises to pay in depreciated currencies (bond holders, savings bank depositors, etc., and other creditors), all business enterprise operated upon fixed rates of charge for the output or service produced or rendered and salaried workers and others dependent upon any form of fixed income. Public Utility enterprises, especially those operating under franchises or contracts requiring fixed rates of charge over long periods of time, have suffered losses aggregating enormous amounts.

The graph "Plate IV-A" reveals the purchasing power of the dollar as measured in terms of the average wholesale price of all commodities, the purchasing power of the dollar as of 1913-14 being taken as unity.

THE INFLUENCE OF COMMODITY PRICE MOVEMENT UPON PUBLIC UTILITY VALUATIONS.

"Capital" and "Capital Investments" as pertaining to Public Utility enterprises are ordinarily taken, in the realms of finance and industry, to mean financial investments. In any discussion of the effect of Commodity Price movement upon Public Utility valuations "Capital" and "Capital Investments" should be taken to mean stored up wealth productively employed in business enterprise or rendered available for such productive employment.

Capital when invested in a public utility enterprise becomes fixed. It cannot be withdrawn and turned into other channels of industry as can capital invested in some other lines of industrial endeavor. Ordinarily a public utility business

when once started must continue. Consequently, capital investments in public utility enterprises continue indefinitely and because of the relative permanency of such investments, they may, for practical consideration, be considered perpetual.

Further, due to extension and development required because of increasing population and advance in industry together with changing standards of living, also because of the frequent and rapid changes in the various arts constituting the geneses of public utility enterprises and because of the action of other economic forces, capital in addition to that invested at the start of any such enterprise is required throughout the life of the business. Thus ,the total capital invested in any public utility business of more than a few years standing comprises that capital originally invested in the enterprise together with the various capital amounts accredited thereto less deductions of capital amounts replaced or removed.

Moreover, the rate of turn-over of capital invested in a public utility enterprise is comparatively very slow. Capital invested in other lines of industry may be turned over several times per year whereas the turn-over of capital invested in a large public utility enterprise ordinarily will not average more than once in about from five to ten years and oftentimes only once in a considerably longer period.

The purpose of any valuation of public utility property in cases where rates of charge for public utility services are in question should be the determination of the amount of wealth employed in the enterprise and thereby dedicated to the use, convenience and service of the public. Heretofore, in such cases, the attempt has ben to measure the property values of public utility nterprises by consideration of the Cost of Reproduction as of the date of consideration, so-called Actual Investments in Fixed Capital as of the date of consideration and the amount and market value of Stock Shares issued together with the amount and market value of the Funded Debt outstanding against the property.

Thus far in all well-considered cases, Cost of Reproduction, Financial Investment, Stocks and Bonds, etc., and other so-called evidences of value have been taken into consideration in the determination of what Courts and Commissions are pleased to denominate "Fair Value." "Fair Value" in all such cases being an expression in terms of money of the estimated amount upon which the enterprise should be entitled to earn a return; the fact that the monetary unit is the unit of account and not an absolute unit of value and the further fact that such expression consequently cannot be a true statement of property value being ignored.

Such procedure constitutes an attempt to compare fiscal statistics that are not at all directly comparable and confusion must necessarily result because of the fact that confusion must always arise from the acceptance of fiscal statistics, without proper interpretation, as economic facts. Thus, the attempt to compare book records of Fixed Capital Investments and other accounts with Reproduction Cost is hopeless unless the book accounts are converted to a basis comparable with Reproduction Costs.

Inasmuch as the total capital invested in a public utility property consists of the capital invested at the start of the enterprise plus accretions thereto less deductions of capital amounts replaced or removed, the total capital invested in a public uility property consists of the net sum total of capital investments accreted to the enterprise throughout a comparatively extended period of time. The monetary unit possesses different values at various stages of the economic cycle. Consequently, capital investments in public utility properties accrete at various inter-

vals throughout a period of time dating from the start of the enterprise during which the monetary unit, the dollar, possesses palpably different values.

An investment of a given amount of money represents an investment of wealth varying as to amount with the varying value of the dollar. Hence, in view of the fact that capital investments in Public Utility properties are cumulative amounts of wealth accreted at various times throughout long periods during which the value of the dollar undergoes pronounced change, it becomes at once apparent that an expression of the value of Public Utility properties in terms of the monetary unit without a proper interpretation of the monetary unit in terms of value cannot be a true statement of the amount of wealth employed in the enterprise. Consequently, any such expression is not and cannot be under any circumstances a true statement of property value.

"Currency" is ordinarily taken by classical economists to mean metallic coinage and notes based thereon or temporarily authorized by public authority. In any discussion of the relation between volume of currency and commodity prices, currency should be taken to mean anything received for a commodity as an intermediary instrument of commercial exchange. Accepting this broader definition, inquiry discloses that the tendency of commodity price movement over long periods is constantly upward and the more extended the inquiry the more patent becomes the fact that the reason for this constantly upward tendency is that the art of creating currency on the basis of credit progresses with increased population, increased production and advance in industrial arts.

Accordingly, high prices themselves contribute greatly to currency inflation, because continually increasing prices promote expectation of further increase which engenders confidence of the kind that results in credit expansion which may be most readily employed in the creation of currency. Thus arises the notoriously vicious price cycle; rising prices increase of currency through rise in prices, then higher prices in consequence of currency inflation. This cycle may be expanded to embrace each step in the evolution of prices from a given level to a higher level as desired, the results are always the same. Each succeeding higher price level is but expression of the depreciation of the purchasing power of the monetary unit.

It is an economic axiom that there can be no true basis for currency other than realizable wealth exchangeable for other wealth. The amount of currency in force at any given time is however not limited to the amount of wealth existing at that time. The amount of currency in force at a given time is in fact created by capitalizing both wealth and credit the capitalizing of credit producing a greater or less amount of currency as conditions may determine.

Uncovered currency is nothing more than accommodation bills that must be replaced by other similar bills insofar as the future increase in wealth will not enable their withdrawal. Increase of currency does not mean increase of wealth. As the volume of currency in force exceeds realizable wealth so does the monetary unit decrease in purchasing power proportionatly, due allowance being made for the velocity of money circulation.

Thus, a half dollar of wealth may become a dollar in currency and commercial transactions may be effected upon that basis. A million bushels of wheat may be priced at a certain time at two or two and a half times the price of wheat prevailing some years previous. Nevertheless, they remain only a million bushels of wheat and will feed exactly the same number of people as would a million bushels of wheat in any other year. Moreover, neglecting the forces of supply and demand, a million bushels of wheat are worth on an average just so many bushels

of corn, tons of pig iron, pounds of copper or a definite quantity of any other commodity

Were a statement of the Reproduction Cost of a million bushels of wheat desired it is most apparent that Reproduction Cost would be the prevailing price of wheat as of the date of consideration. It could not be held however, because of the fact that the reproduction cost was two or two and a half times what the reproduction cost (or prevailing price) of wheat would have been a few years previous to the date of consideration that Reproduction Cost in this case reflects an appreciation in the value of wheat. The relative worth of wheat remains comparatively constant, hence the statement of Reproduction Cost in this case would constitute a statement of the value of wheat in terms of the moneary unit as of the date of consideration, the purchasing power of the monetary unit having depreciated when compared with its purchasing power of a few years previous.

Thus it is with Public Utility valuations. The Reproduction Cost of a Public Utility Property, proper interpretation of the reproduction theory being understood, is but an expression of the value of property, which value remains comparatively constant, in terms of the monetary unit; the monetary unit in such cases being interpreted in terms of value in accordance with purchasing power and hence worth as of the date of consideration. Considerable difference obtains of course between the methods employed in determining the Reproduction Cost of wheat and the determination of the Reproduction Cost of a Public Utility property. This difference obtains because of there being no open market for the exchange of Public Utility properties and further because of the intricacies encountered in the application of the Reproduction Theory in the determination of the property value of a Public Utility.

Assuming a reasonable interpretation of the Reproduction Theory a statement of the Reproduction Cost of a Public Utility property as compared with a statement of Financial Investment does not reflect enhancement nor depreciation, as the case may be, of property value. If Courts and Commissions have not recognized this feature of Reproduction Cost Valuation in past decisions, the omission may be ascribed to the fact that neither Courts nor Commissions have in any case had presented to them all of the facts pertaining to the determination of property value.

The non-inclusion of these vitally important facts in the presentation of Public Utility valuations may be attributed only to negligence on the part of the representatives of Public Utilities. Moreover, in cases where Reproduction Costs has revealed amounts in excess of the book accounts of fixed capital the representatives of Public Utilities have been further remiss in attempting to defend so-called appreciation or enhancement of value. Assuming always a reasonable interpretation of the Reproduction Theory, no enhancement in value occurs. Assuming also the fixed capital accounts to be adjusted so as to render them comparable with Reproduction Costs, the difference in amounts between Reproduction Cost and the fixed capital accounts becomes very much less apparent. Reproduction Cost in such cases beocmes a statement of property value in terms of the dollar in accordance with its prevailing worth.

From this it becomes very apparent indeed that the influence of commodity price movement upon Public Utility valuations compels the acceptance of Reproduction Cost as being a true statement of property value, such acceptance being contingent however upon a proper interpretation of the Reproduction Theory. And, from what has gone before it becomes further apparent that a proper interpretation of the Reproduction Theory proceeds only from the intelligent interpretation of the basic economic principles underlying property value.

THE INTERPRETATION OF THE MONETARY UNIT IN TERMS OF VALUE IN THE EVALUATION OF PUBLIC UTILITY PROPERTIES.

In the evaluation of Public Utility properties for the purpose of establishing fixed capital charges in cases where rates of charge for Public Utility service are in question, the determination of the property value of a Public Utility enterprise, or the amount of wealth dedicated by such enterprise to the use, convenience and service of the public, requires expression of property value in terms of the monetary unit, i. e., the dollar. The dollar is almost universally accepted as a unit of value, whereas the dollar is in fact the unit of account and not an absolute unit ot value. Therefore, because of the fact that the dollar is the unit of account and not an absolute unit of value, an expression of property value in terms of the dollar obviously does not constitute a true statement of value unless the dollar, the unit of account, is interpreted in terms of value. The interpretation of the dollar in terms of value in the determination of the property value of a Public Utility enterprise may be accomplished by the employment of either one of two devices as follows:

The equitable rate of interest return on investments in fixed capital may be determined by taking as unity, a given rate of interest return corresponding to a certain worth of the dollar; expressing investment in terms of dollars and rate of interest return in terms of percentage of investment. The equitable rate of interest return as of the date of consideration may then be determined by taking an increase or decrease of the rate of interest return representing unity in direct proportion to the increase or decrease in the worth of the dollar as of the date of consideration as compared with the worth of the dollar comparable with the rate of interest return representing unity. The determination of the equitable rate of interest return by this operation necessarily becomes a highly involved procedure. So much so in fact as to render the employment of such device somewhat unwieldy especially in the determination of fixed capital charges other than interest.

The unwieldy complications arising in the proper application of this procedure are attributable largely to the fact that the determination of the rate of interest return representing unity implies the evaluation of the dollar *per se*.

Also there arises the question of determining the amount by which the rate of interest return representing unity should be either increased or decreased. This implies a definite statement of the decreasing or increasing worth of the dollar over comparatively limited periods which can result only from a most comprehensive study of the average worth of the dollar as revealed by commodity price statistics. Furthermore, there occurs the question of determining an equitable amount of fixed capital against which the equitable rate of interest return is to be charged which implies the appraisal of financial investments.

By far the more practicable procedure in the interpretation of the dollar in terms of value for the purpose of establishing fixed capital charges in cases where rates of charge for Public Utility service are in question may be briefly stated as follows: The value of that property devoted to the use, convenience and service of the public is expressed in terms of the monetary unit, the unit of account, interpreted in terms of value by means of a reasonable interpretation and application of the "Cost of Reproduction" theory. To fulfill the requirement of expressing value in terms of the unit of account, the dollar, the "Cost of Reproduction" theory must necessarily be interpreted in accordance with the basic economic principles underlying property value.

The interpretation of the dollar, the unit of account, in terms of value by the application of the "Cost of Reproduction" theory interpreted in accordance

with the basic economic principles, is accomplished in the evaluation of Public Utility properties by the determination of the normal price of materials and labor as of the date of valuation; materials and labor being component parts of the various physical instrumentalities comprised in that property dedicated to the use, convenience and service of the public.

The normal prices of material and labor as determined in accordance with the basic economic principles underlying property value make the bases upon which are evolved reproduction unit costs applicable to property elements in the determination of Reproduction Cost. In the evolution of reproduction unit costs upon these bases, construction expenditures other than expenditures for materials and labor are automatically adjusted to the basis of the normal labor and material prices. Likewise in the evaluation of inherent property rights other than property rights in physical instrumentalities, the reproduction costs of such property rights are automatically adjusted to the basis of the normal labor and material prices.

The determination of the normal price of material as of a date certain is accomplished by a proper interpretation of price statistics, commodity price statistics being employed as a basis of consideration. Normal commodity prices as of the date of valuation and the method employed in the determination of same are taken as criteria from which are determined the normal prices of materials other than commodities. The determination of the normal price of labor as of a date certain is accomplished by a proper interpretation of labor statistics.

Provided the methods employed and the resultant commodity and labor prices fulfill requirements as herein set forth, the valuation resulting from the pursuance of the procedure as described constitutes an expression of property value in terms of the monetary unit, the dollar, interpreted in terms of value in accordance with the purchasing power and hence prevailing worth as of the date of consideration. Such valuation therefore fulfills all requirements of any valuation of Public Utility property for the purpose of establishing fixed capital charges in cases where rates of charge for Public Utility service may be in question.

Inasmuch as Reproduction Cost thus established is a statement of property value in terms of the monetary unit interpreted in terms of value as of a date certain, it is most apparent that because of the fact that book accounts of fixed capital investments constitute a statement of financial investments which are ordinarily perfected at various times throughout a comparatively extended period during which the dollar possesses palpably different values, the two statements cannot be directly comparable. In order to render such statements comparable the statement of financial investments in fixed capital must be converted into a statement of property value expressed in terms of dollars in accordance with the worth of the dollar prevailing as of the date of consideration. Which means, that inasmuch as Reproduction Cost properly interpreted reveals the amount of wealth invested in the enterprise; the book accounts, in order to render the two statements comparable, must be so interpreted as to also reveal the amount of wealth invested in the enterprise. When this is done, assuming of course the book accounts to have been properly established and maintained, the differences in amounts between Cost of Reproduction and the book accounts of fixed capital investments becomes not so apparent as in cases where no such reconciliation of statements is attempted.

The fascinating idea that public authority can by some sort of fiscal legerdemain stabilize commodity prices and the purchasing power of the monetary unit, has persisted in the minds of men to a greater or less extent for a great many

years. Inspired by this idea certain minds have in the past endeavored to evolve a workable plan whereby their ideals might be attained. In view of the present day knowledge of the subject it cannot be denied that such endeavors have always been indefinitely far from the goal of attainment and will perhaps never succeed

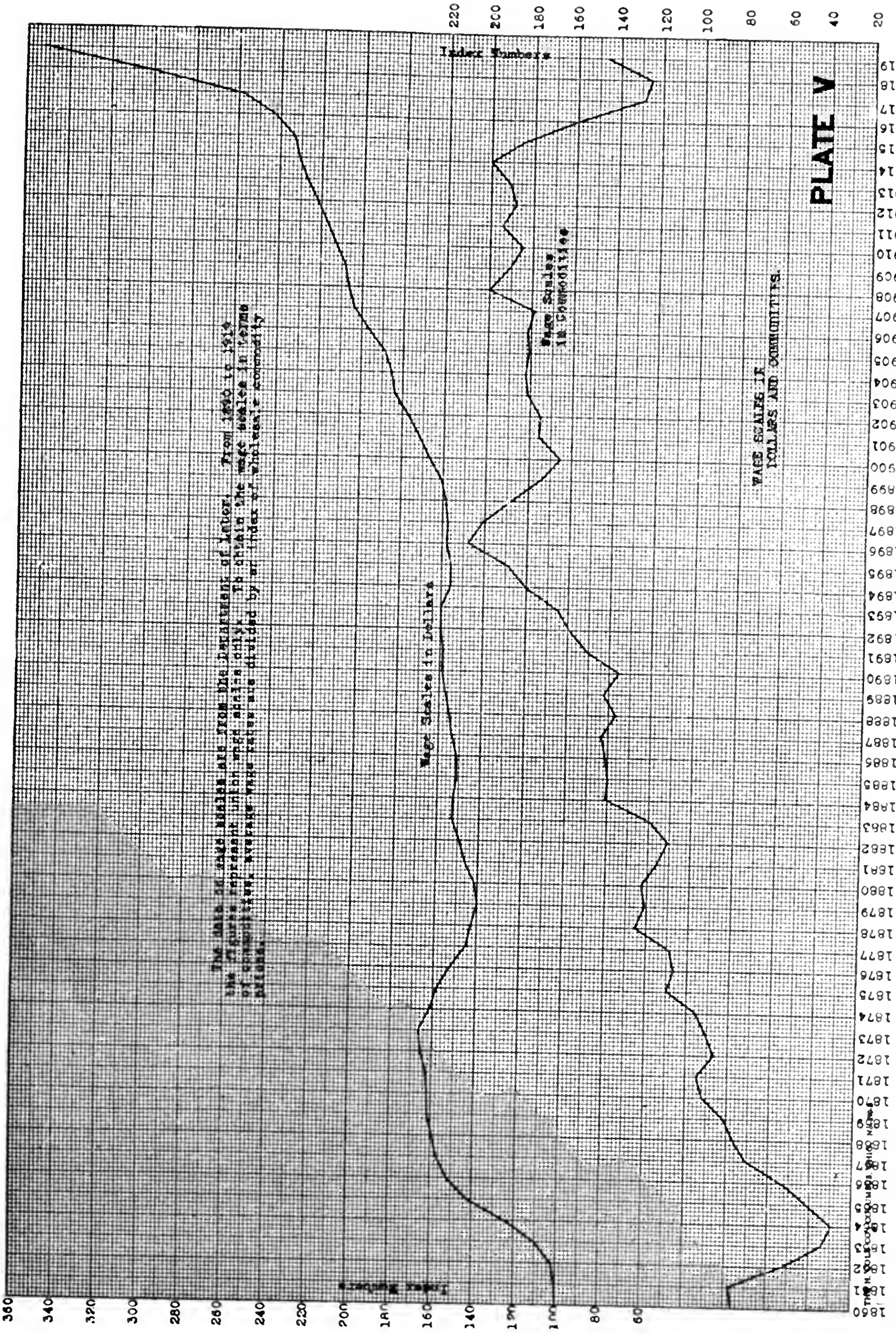

Plate V. Wage scales in dollars and commodities.

but partially. Nevertheless, to those engaged in this line of speculation may be accorded the honor of having excited and promoted attentive interest in economic research. It is not a new idea; notwithstanding the fact that it is being advocated from time to time by succeeding champions as an immensely important new economic truth.

Commodity price movement and hence the varying purchasing power of the monetary unit is but manifestation of certain phases of a most complex economic system yielding to the aggregate influence of many coplex and variable enonomic forces. The laws or principles governing these forces are absolute; they can neither be abrogated nor altered by public opinion, legislative enactments, judicial decree or corporate policy. Thus it is that commodity price movement or the varying purchasing power of the monetary unit is the effect of the action of economic forces over which public authority has little or no control.

The currency system can undoubtedly be improved so as to alleviate, to some extent at least, the deleterious effects of anamalous economic conditions. However, no matter to what extent possible improvements in the currency system may be perfected, economic forces will obtain and the monetary unit will continue to vary in purchasing power in response to the influence of these forces. Consequently, with extended inquiry it becomes increasingly clear that in the evaluation of Public Utility properties for the purpose of determining fixed capital charges in cases where rates of charge for Public Utility service are in question, property values must be expressed in terms of the monetary unit interpreted in terms of value. Otherwise, either the Public or the Public Utility is unduly deprived of property.

Expression of the property value of a Public Utility enterprise in terms of the monetary unit interpreted in terms of value is accomplished by the determination of the Reproduction Cost of all property and property rights possessed by that enterprise. To fulfill the requirements of expressing property values in terms of the monetary unit interpreted in terms of value, Reproduction Cost must be determined in accordance with the economic principles underlying property value. Reproduction Cost thus determined constitutes a statement of that amount of wealth dedicated by the enterprise to the use, convenience and service of the public or a statement of the amount of capital invested in the enterprise, as measured in terms of dollars in accordance with the value of the dollar as of the date of consideration, which is the amount upon which the enterprise is entitled to earn a return.

NORMAL LABOR PRICES.

Normal Labor Prices, as the term is here used, should be taken to mean prices that fairly interpret the value of the dollar in terms of labor for the purpose of determining the reproduction cost of Public Utility property; reproduction cost being assumed to fulfill requirements as hereinbefore set forth.

Referring to 'Plate V," thereon will be noted a graph of average wage scales in dollars for the years 1860 to 1919 inclusive, also a graph of the same average wage scales in terms of commodities. In studying these graphs it may be well to note that both graphs represent wage *scales* and not wage income. In the earlier days, the prevailing scales of wages increased and decreased in some instances, in response to the influence of general business conditions. The business crisis of 1873-1884 and 1893, for example, are marked by an abrupt decrease in wage scales. Since the depression of 1894-97, however, the labor unions have succeeded in increasing and maintaining labor rates so that there has been no reduction in the average union wage rates.

The data on wage scales are from the United States Department of Labor. From 1890 to 1919 the graph represents union wage scales only. To obtain the wage scales in terms of commodities, average wage rates are divided by an index of wholesale commodity prices.

Referring to "Plate VI," thereon will be noted graphs of "Average Earnings per Worker," "Average Retail Food Prices" and "Wages in Terms of Commodities" for the years 1914 to 1919 inclusive. The scale figures to which these graphs are drawn are ratios, wages being assumed to be at par with retail food

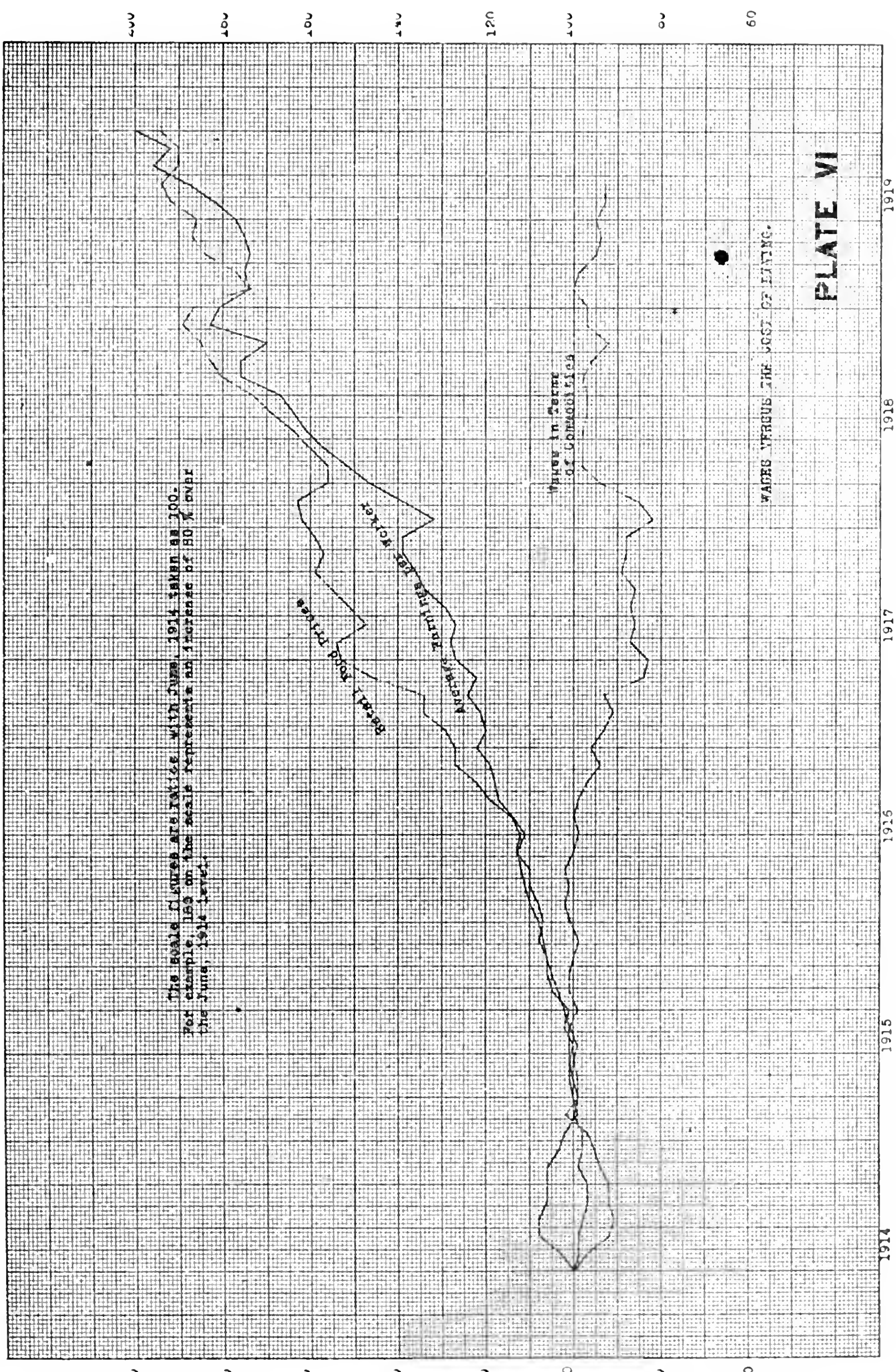

Plate VI. Comparison of wages and cost of living.

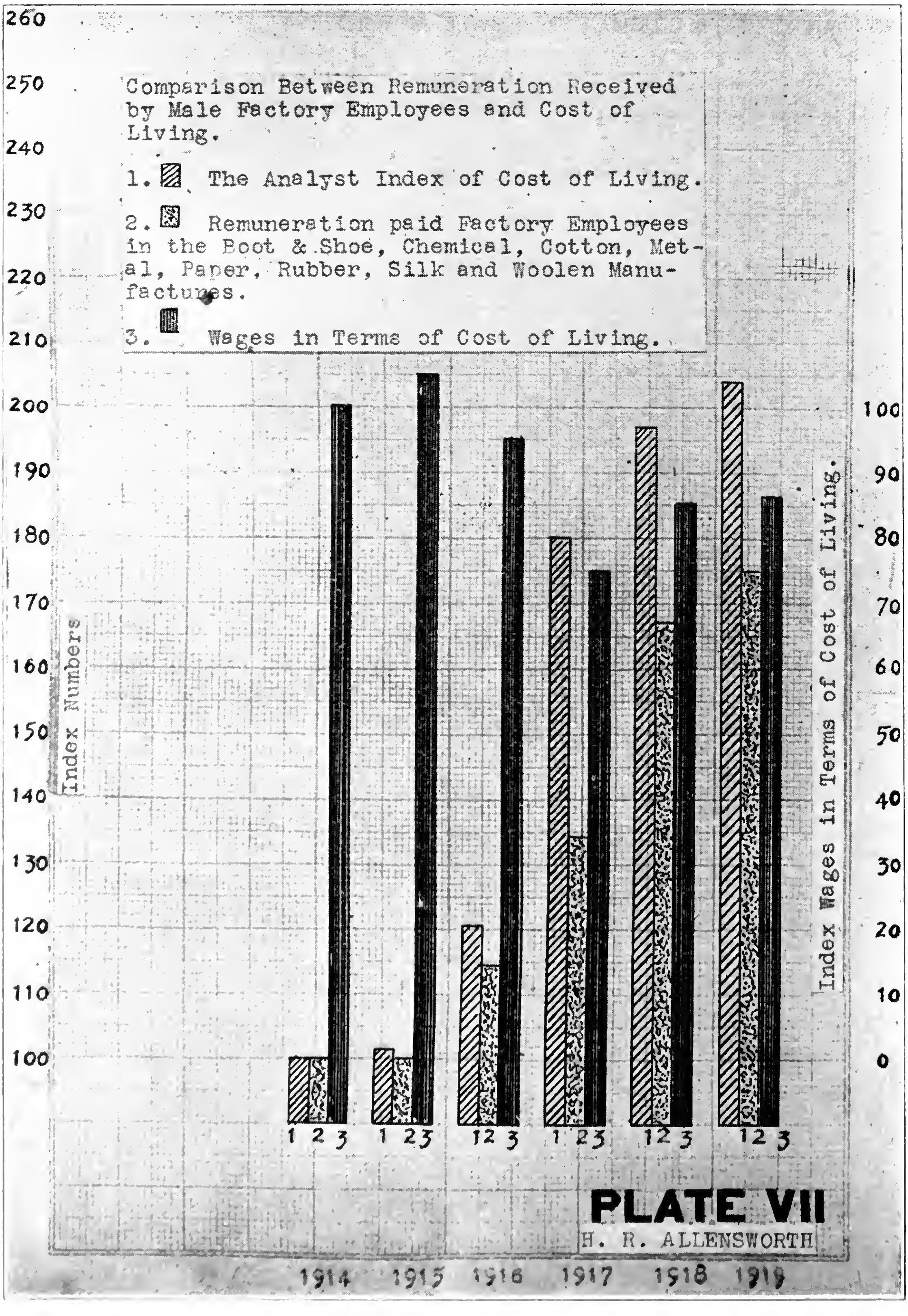

Plate VII. Comparison between remuneration received and cost of living.

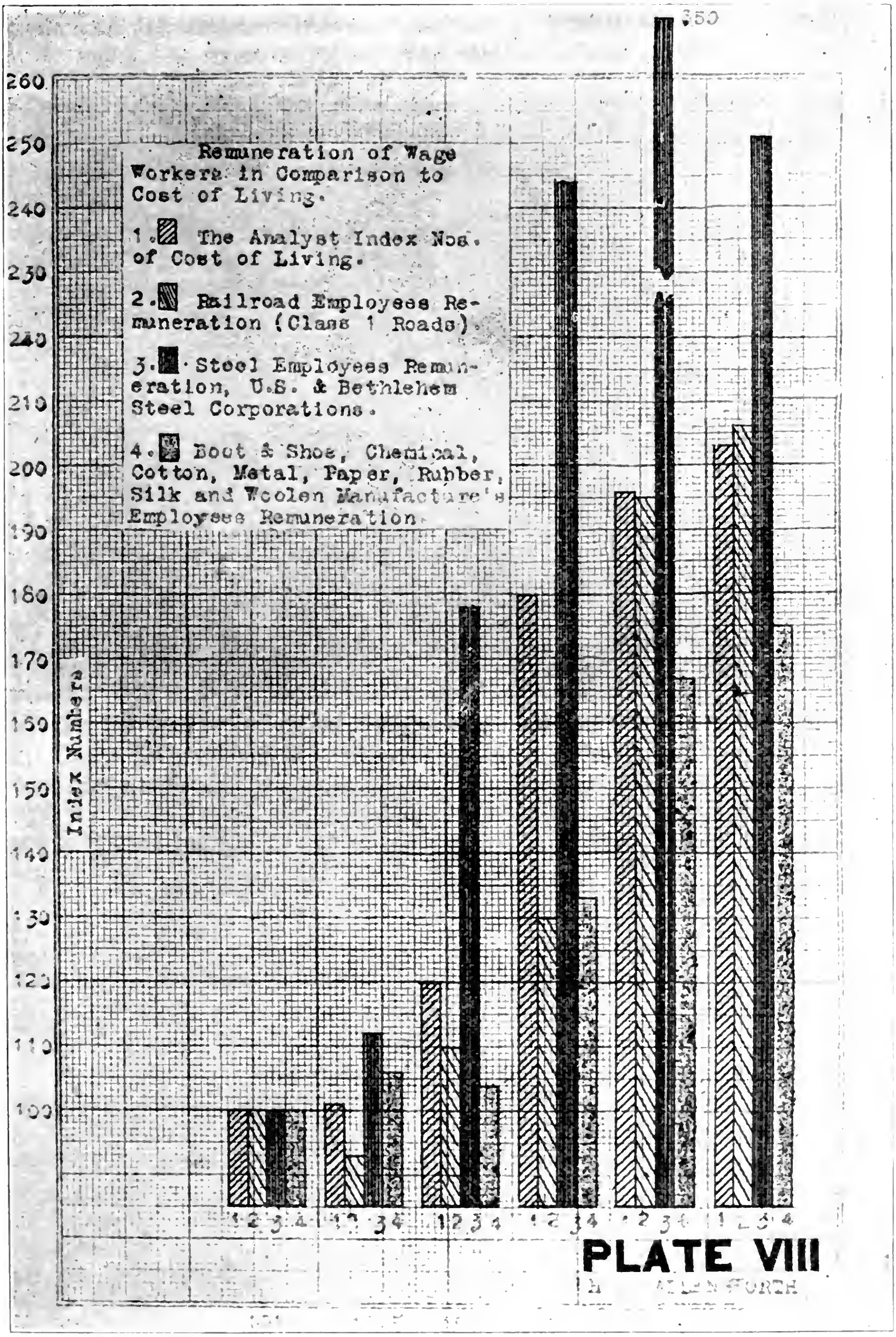

Plate VIII. Comparison between remuneration received and cost of living.

prices as of June, 1914. For example, 180 on the scale represents an increase of 80% over June, 1914, level of prices and earnings. The "Earnings per Worker" graph is based upon the records of the New York State Industrial Commission. The food price index is that of the United States Department of Labor.

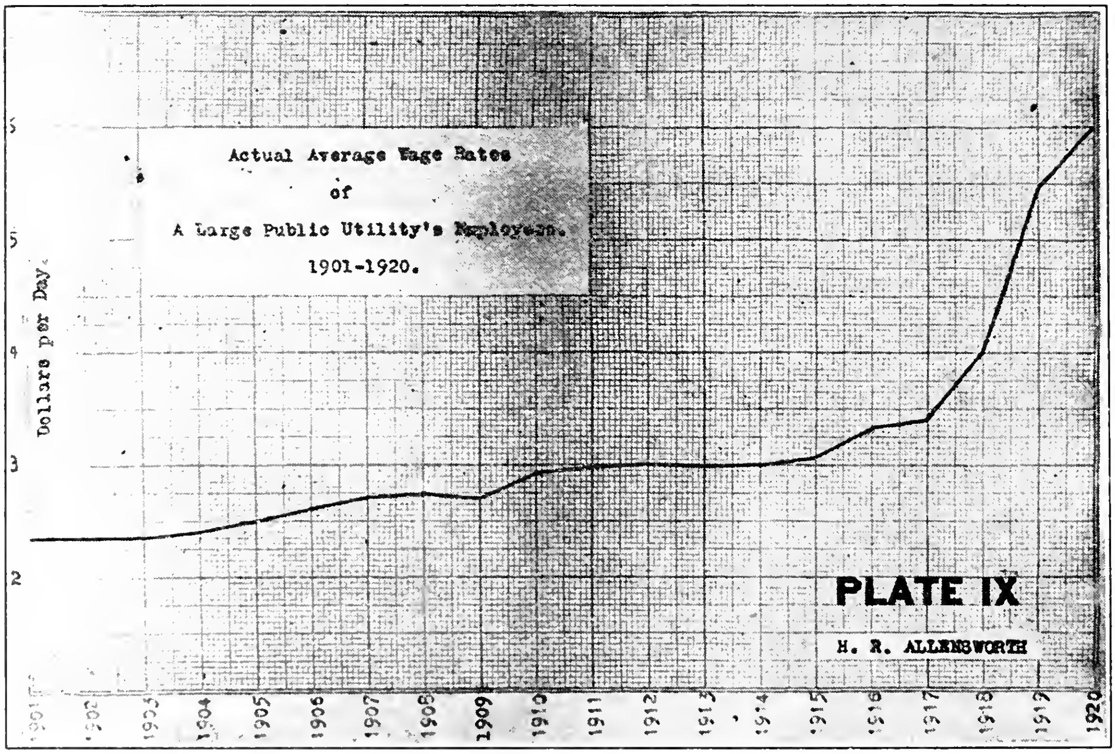

Plate IX. Average wage rates.

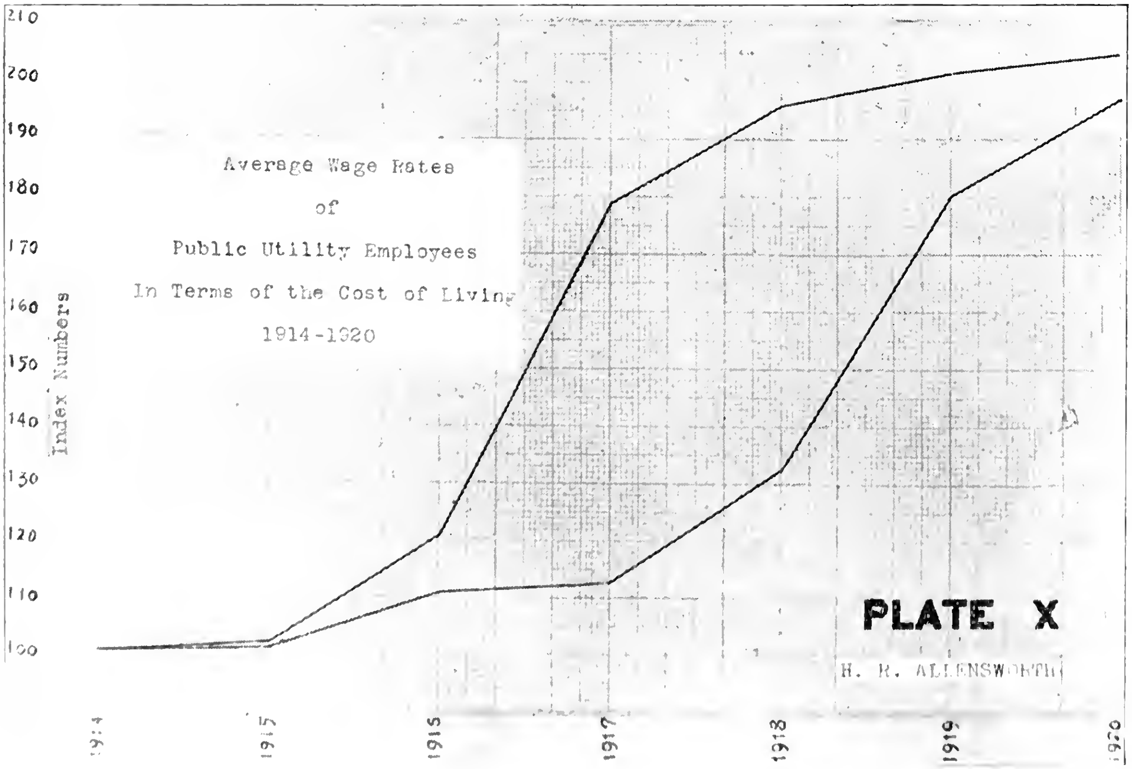

Plate X. Average wage rates in terms of cost of living.

Referring to "Plate VII," thereon will be found charted to index numbers, "Remuneration Received by Male Factory Employees," "The Analyst Index" of the food cost of living and "Remuneration In Terms of the Cost of Living," for the years 1914 to 1919 inclusive; "Employees Remuneration" being assumed to be at par with the "Cost of Living" as of the year 1914.

"Plate VIII" is a chart similar to "Plate VII" with the addition of the remuneration received by Railroad and Steel Industry Employees charted to Index Numbers; which, in view of the explanation of "Plate VII" should be self-explanatory.

Referring to "Plate IX," thereon will be noted the average actual wage rate of various classes of employees of a large Public Utility; wage rates of only those employees either wholly or partially engaged in construction work being shown, for the years 1901 to 1920 inclusive. The wage rates shown are the representative rates in vogue each year.

"Plate X," presents in the form of a graph the average actual wage rates shown on "Plate IX" for the years 1914 to 1920 inclusive, adjusted to Index Numbers. Also is shown the Analyst Index of the cost of living. Wage rates are assumed to be at par with the cost of living as of the year 1914.

The significant fact revealed by all of the statistical evidence relative to labor wage rates and wages herein submitted is that labor wage rate movement, in this country at least, has always lagged behind commodity price movement. Or, stated in other words, while it is true that labor wage rates increase with the depreciation of the purchasing power of the dollar; the increase in labor wage rates and wages, especially during recent years, has not been sufficient, excepting in a few notable cases, to keep pace with the lessened purchasing power of the dollar. This is particularly true relative to wage rates and wages of Public Utility employees including all classes of employees engaged in construction work.

Conversely, statistical evidence reveals also the fact that wage rates and wages do not decline with appreciation of the purchasing power of the dollar. With the close of the Civil War, wholesale prices of commodities declined rapidly during the year 1865 and from that time forward declined gradually to the low level of 1896-97. Retail prices and hence the cost of living stood firm throughout 1865-66 and gradually declined to lower levels. However, despite the panic of 1873 retail prices did not reach pre-war levels until 1878, or thirteen years after the close of the war. Meanwhile, labor wage rates increased during the period 1865-73 and the margin between wages and prices widened.

Economic conditions are so vastly different today from those obtaining during the years subsequent to the Civil War that no argument from analogy is sound. However, it cannot be denied that the effects of the economic conditions obtaining during that period and the effects of economic conditions obtaining at this time are strikingly similar, so much so as to render a comparison of these effects enlightening.

Thus it seems that while it is true that during recent years and especially during the period of the recent world war the increase in labor wage rates and wages have not been sufficient to keep pace with the lessened purchasing power of the dollar it may be reasonably expected that wage rates will continue at the present or higher level, that retail prices will decline and to the extent that inequalities in wage rates have obtained during recent years, labor will be compensated to perhaps a very great extent during the next few years.

The purpose of any determination of normal labor and material prices in establishing the property value of a Public Utility enterprise is an expression of

the amounts the enterprise has invested in labor and materials in terms of the dollar as of the date of consideration. It should be most apparent, from what has gone before, that for the purpose of establishing the reproduction cost of the property and property rights of any Public Utility enterprise "Normal Labor Prices" are the labor prices obtaining as of the date of consideration.

Specifically, the normal labor prices applicable in any determination of Reproduction Cost of any Public Utility property are the labor prices obtaining as of the date of consideration. Reproduction Cost being understood to fulfill requirements as hereinbefore set forth.

NORMAL COMMODITY PRICES.

In accordance with the preceding definition of normal labor prices, "Normal Commodity Prices," as the term is here used, should be taken to mean prices that fairly interpret the value of the dollar in terms of commodities for the purpose of determining the reproduction cost of Public Utility property; reproduction cost being assumed to fulfill requirements as hereinbefore set forth.

Commodity price movement, with proper qualification, is a barometer of the aggregate effect of a most complex system of economic forces in process of equalizing values and, when properly interpreted, becomes an index of the rise and decline of the purchasing power of the monetary unit.

In the determination of the reproduction cost of Uublic Utility property for the purpose of establishing fixed capital charges in cases where rates of charge for Public Utility service are in question, we have no immediate interest in instantaneous values of the monetary unit. We are confronted with the problem of determining the reproduction cost of the enterprise as expressed in terms of dollars interpreted in terms of value as of the date of consideration. Reproduction Cost, to fulfill all requirements in such case must be somewhat more stable than the day to day, month to month, year to year, fluctuations in the purchasing power of the monetary unit as revealed by commodity price movement.

The determination of normal commodity prices for the purpose of evaluation as hereinbefore set forth is illustrated by "Plate XI." Thereon will be noted a graph of the average price of Lake copper prevailing each year 1864 to 1918 inclusive, together with th eaverage price throughout the 55-year period. The curve of average price throughout the 55-year period shows the normal price as of 1918 to be 21 cents the pound.

Also, on "Plate XII" will be noted the average price of lead prevailing each year 1889 to 1918 inclusive together with average price throughout the 30-year period. The curve of average price throughout the 30-year period shows the normal price as of 1918 to be 6 cents plus, the pound.

Normal commodity prices when thus determined become criteria from which are determined normal prices of materials other than commodities.

COMPARISON OF REPRODUCTION COST AND BOOK ACCOUNTS OF FIXED CAPITAL INVESTMENTS.

The application of the Reproduction Theory as interpreted in accordance with economic principles, in the evaluation of the property and property rights of Public Utility enterprise, which interpretation establishes basic labor and commodity prices as herein set forth, yields an amount that fairly states the property value of that enterprise in terms of the dollar interpreted in terms of value as of the date of consideration.

It has been stated that book accounts of fixed capital investments when interpreted in terms of property value expressed in terms of dollars in accordance with the relative worth of the dollar prevailing as of the date of consideration

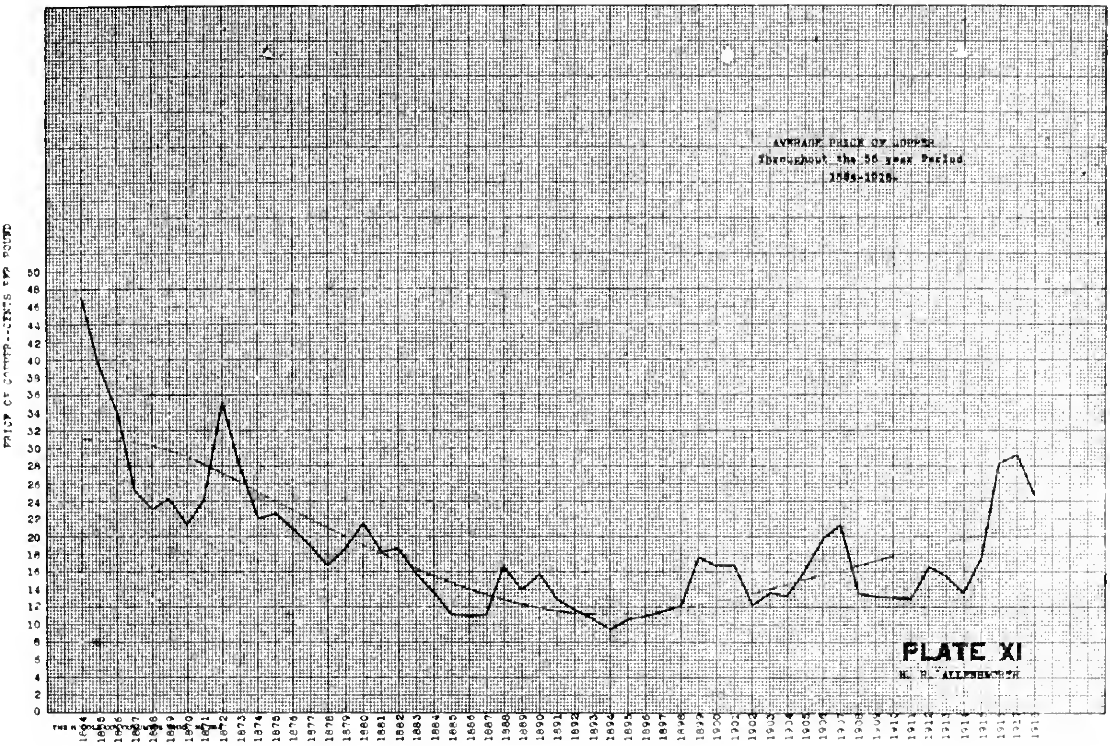

Plate XI. Average price of copper 1861-1918.

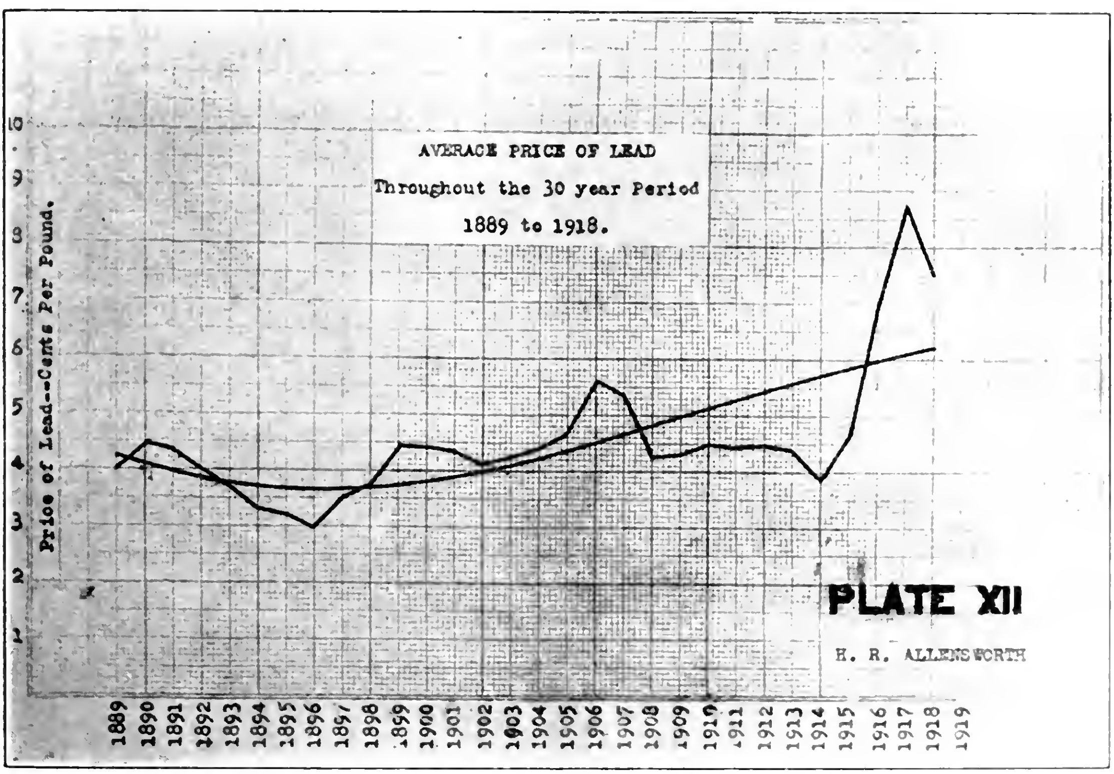

Plate XII. Average price of lead 1889-1918.

should be comparable with the property value as determined by such valuation, provided book accounts have been properly established and maintained.

The principles herein set forth were followed in the evaluation of a Public Utility, the date of consideration being July 1st, 1918. Taking this case for the purpose of illustration, the following collation of appraised value and fixed capital investments as revealed by the book accounts of the enterprise is submitted in support of reproduction cost as a true measure of property value when determined in accordance with the principles hereinbefore set forth.

The books of account revealed the various amounts added to the fixed capital accounts, each year beginning with the first year of the corporate existence of the enterprise up to the date of consideration.

Inquiry disclosed, however, the fact that prior to January 1st, 1913, no attempt had been made to include "Engineering and General" expense and "Interest during Construction," in construction costs. Consequently, to render the appraised value comparable to the book accounts of fixed capital it was necessary to deduct the "Engineering and General" expense and "Interest during Construction" costs from the appraised value.

The appraised value of the physical property as of July 1st, 1918, amounted to $14,413,467.60. Of this amount, Engineering and General Expense constituted $585,423.32, and Interest during Construction $1,093,570.98, or a total of $1,678,994.30 to be deducted from the appraised value of $14,413,467.60. This results in a net amount of $12,734,473.30 for collation with the book accounts of fixed capital investments.

The graph "Plate XIII" reveals yearly average index numbers of commodity prices together with the average commodity price index throughout the period shown. The relative worth of the dollar from year to year throughout the period 1904 to 1918 inclusive as revealed by commodity price statistics is determined (Table 1) from the average commodity price index shown on "Plate XIII" assuming the relative worth of the dollar to be par as of 1918.

By the application of the factors shown (Table 1) to the actual amounts

TABLE No. 1.

Year.	Average Index Number.	Factor.
1904	.85709	1.37743
1905	.87908	1.34297
1906	.90238	1.30830
1907	.92673	1.27392
1908	.95182	1.24032
1909	.97733	1.20794
1910	1.00289	1.17716
1911	1.02832	1.14805
1912	1.05322	1.12080
1913	1.07759	1.09556
1914	1.10091	1.07235
1915	1.12306	1.05120
1916	1.14384	1.03210
1917	1.16305	1.01506
1918	1.18058	1.00000

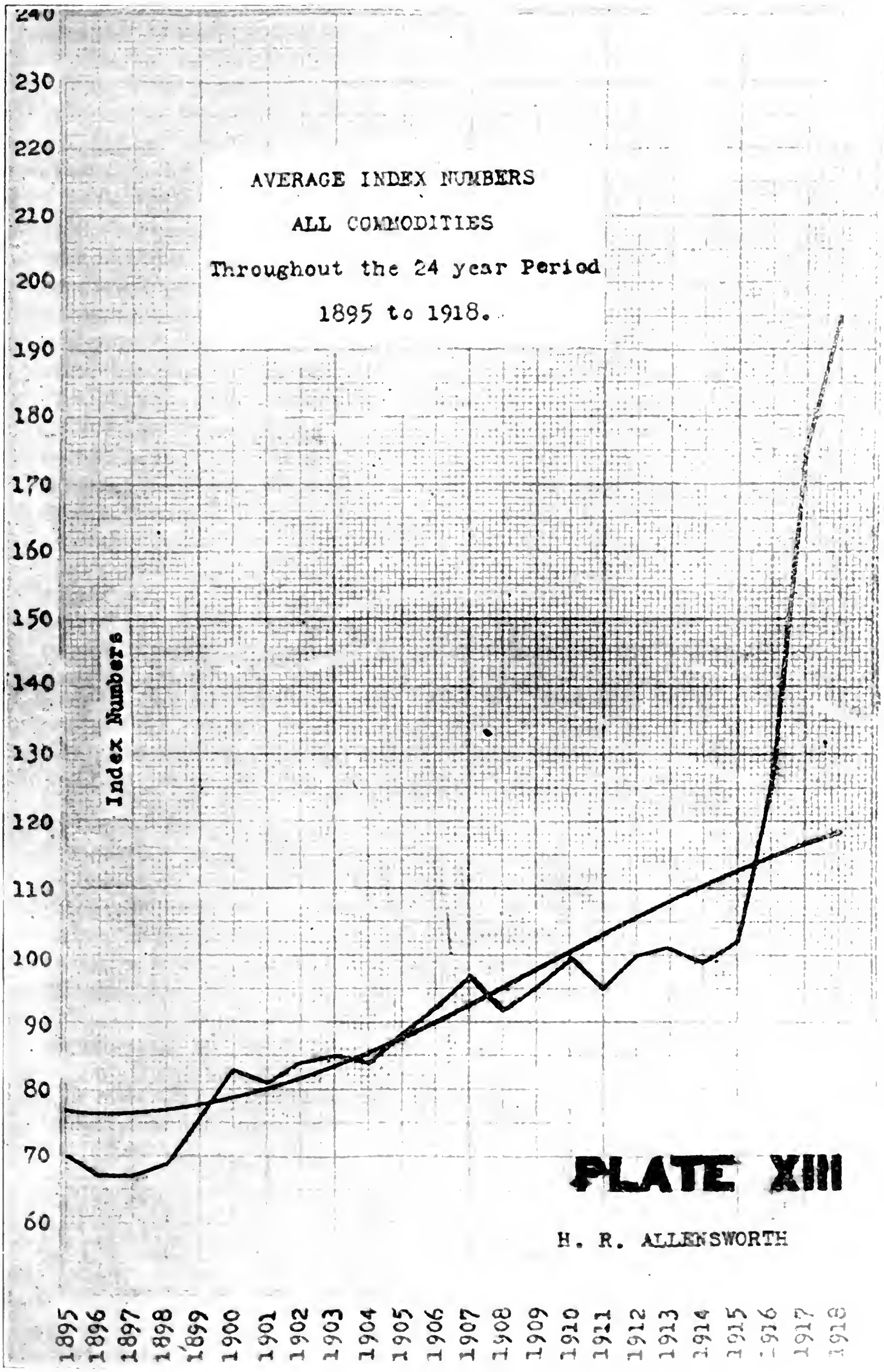

Plate XIII. Average index numbers of all commodities 1895-1918.

invested in fixed capital each year, the annual investment in fixed capital is expressed in terms of the dollar as of 1918 and the summation of these amounts constitutes an expression of the total fixed capital investments in terms of the dollar as of 1918 (Table 2).

TABLE No. 2.

Year.	Investment During Period.	Factor.	Investment Adjusted to Value of Dollar of 1918.
1904	159,547.50	1.37743	357,508.51
1905	507,505.81	1.34297	681,565.08
1906	4,346,494.90	1.30830	5,686,519.28
1907	364,525.32	1.27392	464,376.10
1908	624,189.88	1.24032	774,195.19
1909	438,755.99	1.20794	529,990.91
1910	440,689.43	1.17716	518,761.97
1911	285,094.84	1.14805	327,303.13
1912	396,609.02	1.12080	444,519.39
1913	332,167.88	1.09556	363,909.84
1914	379,636.78	1.07235	407,103.50
1915	540,031.43	1.05120	567,681.04
1916	1,371,869.60	1.03210	1,415,906.61
1917	459,757.57	1.01506	466,681.51
First 6 mos. 1918	73,865.23	1.00000	73,865.23
Total Book Investment to July 1, 1918			$13,079,887.29

However, before comparing the total amount shown (Table 2) with the appraised value it is necessary to make a further adjustment of the amounts revealed by the books of account because of the fact that in these accounts there is found charges entered through the period January 1st, 1913, to December 31st, 1917, as follows:

Franchises	$ 1,859.16
Other Intangible Capital	2,848.89
Interest during Construction	88,747.17
Engineering and Superintendence	104,296.20
Law Expenditure during Construction	2,275.45
Miscellaneous Construction Expenditures	50,985.48
Total	$ 251,012.35

Adjusting these expenditures to the purchasing power of the dollar of 1918:

Intangibles, Interest, etc. (Book figures x 1.0447)	$ 262,232.60
The summation of Table 2 shows	13,079,887.29
Net amount for collation (Book)	12,817,654.69
Net amount for collation (Appraisal)	12,734,473.30
Difference	83,181.29

This collation of the two amounts derived from the two different sources reveals the fact that the difference between the book accounts of fixed capital investment and the appraised value, both accounts being adjusted as explained, are in agreement to within six-tenths of 1 per cent.

While it is admitted that it should not be expected that the exceedingly close agreement occurring in this case between appraised value and book accounts of fixed capital investments as adjusted will be attained in other cases it cannot be denied that barring any abnormal features in book records, reproduction cost when determined in accordance with principles herein set forth and book accounts of fixed capital investments, when properly adjusted, should be directly comparable and in close agreement and difference obtaining should be readily explainable.

Furthermore, such agreement between reproduction cost and book accounts proves beyond peradventure that reproduction cost or property value when determined in accordance with principles herein set forth becomes an undeniably true statement of the actual amount of wealth a Public Utility enterprise has invested in the property and property rights of the enterprise as of the date of consideration. Reproduction Cost of property value in such case consequently constitutes an undeniably true statement of the amount of wealth dedicated by the Public Utility to the use, convenience and service of the public in the territory served as expressed in terms of dollars interpreted in terms of value as of the date of consideration.

Therefore the property value shown in such cases becomes a statement of that amount upon which the enterprise is entitled to earn a return as of the date of consideration.

ADDENDUM.

Since the presentation of the foregoing discussion to the Western Society of Engineers (December 9th, 1920) the writer's attention has been directed to the following recently published decision of the United States District Court, Southern District, New York, in re Consolidated Gas Company v. Charles D. Newton, as Attorney General of New York, et al.

P. U. R. 1920 F. P. 483 (Decided August 4th, 1920).

Learned Hand, D. J.: This bill was filed under the leave given in Willcox v. Consolidated Gas Company, 212 U. S. 19, 53 L. ed. 382, 29 Sup. Ct. Rep. 192, to begin a new suit of the same kind after a period of probation should have tested the adequacy of the rate established by the statute. Ten years passed before this was done, and the experience gained meanwhile would, under ordinary circumstances, have been sufficient. However, during that period there occurred the extraordinary rise of prices due to the Great War, which has made the future harder to forecast upon the basis of ten years past experience, than could have been apprehended in 1909, and as a result, we are not in so good a position at the present time to judge of the future effect of the statutory rate as we should normally have been, i. e., the experience of the first seven of the ten years is of little present value.

The defendants wish me for this reason to take an average over the whole period both for the cost of production and capital valuation. Now whatever may be the proper method, that certainly is wrong. The case is not one in which an average can safely be made, because the variations in prices which the whole period covers are not normally recurrent. Averages presuppose that the resulting figure will cover variations, which, though certain or nearly certain within the period taken, are impossible of exact prediction in their occurrence. They may, therefore, be spread over a period precisely as an insurance loss is spread. The recent rise in prices is not of this kind, because there is no reason whatever to suppose that during the next period of say five years, which is long enough to

justify some present action, the same causes will operate in reverse as ha operated in the past. An average would be, therefore, meaningless.

Several reasons lead me to believe that present price levels are not mer transitory, though I recognize the danger of any prophecy. Whatever th precise cause, it is universally conceded to be due to the Great War, and by tl I mean, of course, not to the prosecution of hostilities, but to the econon exhaustion and inflation of the circulating medium which these involved. general, it is a safe inference to suppose that Europe will not be able to resu its ante bellum production for a time measured rather by years than by mont and that the recovery of a sound financial condition will take longer. We, this country, are not only influenced by conditions in Europe, but we are subj to our own local inflation and disorganization of industry, from which no c Constitution is thought to insure it. So far as human foresight can see, tl condition, though probably not permanent—certainly in its present exaggerat form—is bound to exist over a period of some years.

I have just said that the present range of prices seems to me applicable only to the cost of production but to the valuation of the "rate base," i. e., t permanent means of production, and this necessarily involves a decision upon t vexed question as to the values upon which the company is to be permitted to ea its profit. Costs of production involve items which the company must pay bef it begins to see any profit whatever; its economic motive for embarking in, a maintaining, the enterprise depends altogether upon the return which it can out of the property which it has bought and erected into an industrial unit. Her it is the profit, and strictly speaking this alone, which matters with the sto holders. It must be owned that much of the discussion shows either a timid or an inability to grasp any principle in dealing with the "rate base." W deference it appears to me to be merely an abandonment of any attempt to d intelligibly with the question to say that cost of reproduction and the origi cost are each elements to be considered. That statement can mean nothing wh ever unless it is accompanied by a constitutive rule which will establish so standard by which these may be used. It would be understandable to say tl the two estimates should be averaged, but such a rule could obviously comma no support, because it would correspond to no relevant considerations of poli Merely to leave the question with a caution that several elements are to be co sidered is to abandon any effort to solve it.

The recurrent appeal to a just rate and a fair value assumes that the eff is to insure such a profit as would induce the venture originally and that t public will keep its faith so impliedly given. That, I think, involves a ta comparison of the profit possible under the rate with profits available elsewhe i. e., under those competitive enterprises which offer an alternative investme The implication is that the original adventurer would compare future rates, va ing as they would with the going profit, and would find them enough, but more than enough, to induce him to choose this investment. By insuring su a return, it is assumed that the supply of capital will be secured necessary to t public service. As the profits in the supposed alternative investment will the selves vary, so it is assumed to be a condition of the investors' bargain that th profit shall measurably follow the general rates. It is, of course, not releva here to discuss these presuppositions, since they have now the support of autho tative law.

Certain risks in ordinary competitive enterprises can be reasonably anti pated and business practice includes them in an amortization account. New p

cesses and machines are constantly appearing which make the old obsolete; ordinary wear and tear makes necessary replacements. The return, to make these good, is commonly carried in a separate account by all prudent business men and does not come out of the rate. It is true that individual misfortunes cannot be foretold, and these a given company must bear just as any single competitive venture would have to bear them. Among these, however, is not a general rise in prices, which affecting all alike at least after a time, enables each to raise his price not only because of his costs in labor and in materials, but to obtain a proportionate increase in his profit, based upon the increased value of his plant and machinery. All competing producers, who give the same service, must keep an increased number of dollars in capital to do so. The risk of the depreciated dollar is not one which industry in general will bear; it is indeed no risk at all.

Moreover, a profit, based upon the enhanced value of the capital, adds nothing in truth at all to the company's wealth. Though its capital be measured in more dollars and so, too, its profit, that profit is still paid in the fallen dollar and has no greater buying power than it had before. The increased valuation of the capital will, for the years of the depreciated dollar, leave the company exactly as it was; it will merely prevent its being compelled to share its putative fair profit with its customers, which by hypothesis it should not be asked to do. The company gains nothing, the customers lose nothing.

Indeed all this is so much in the primer of economics that it is inconceivable it should be misapprehended as to working capital for instance, and the contrary view has crept in, I think, only when one thinks of the more permanent kinds of capital, and instinctively assumes that the rate will apply after that capital has resumed its former prices, if it ever does. There is in short a tacit assumption that the valuation must last as long as the permanent capital. There is no warrant for that assumption, because precisely the same reasons which compel the "rate base" to be raised after a rise in price, compel it to be reduced after a fall. There is a natural enough reluctance to a continuous re-appraisal of plants and properly so. It must, of course, appear that the variation in prices is not transitory, and the period of probation, before a company is allowed relief, is precisely to insure against that possibility. The chance of loss during that period such companies must endure, and there is an inevitable "lag" in readjustments in each direction. But once it appears that the new price levels are not transitory, it is no answer to the company's complaint to say that at some future time prices may fall. When that time comes, if it does, the property must again be revalued, but meanwhile they are entitled to some protection, and, since thse have become questions for the courts, to the protection of the courts.

The sule of the present reproduction cost, which is a necessary consequence of the foregoing argument, appears to me to have been either expressly or implicitly recognized in all the cases in which the Supreme Court has passed on these matters. Willcox v. Consolidated Gas Co., 212 U. S. 19, 41, 53 L. ed. 382, 29 Sup. Ct. Rep. 192; Des Moines Gas Co. v. Des Moines, 238 U. S. 153, P. U. R. 1915D, 577, 59 L. ed. 1244, 35 Sup. Ct. Rep. 811; Knoxville v. Knoxville Water Co., 212 U. S. 1, 10, 53 L. ed. 371, 29 Sup. Ct. Rep. 148; The Minnesota Rate Cases, 230 U. S. 352, 434, 454, 455, 57 L. ed. 1511, 48 L. R. A. (N. S.) 1151, 33 Sup. Ct. Rep. 729, Ann. Cas. 1916A, 18; San Diego Land and Town Co. v. National City, 174 U. S. 739, 757, 43 L. ed. 1154, 19 Sup. Ct. Rep. 804; San Diego Land and Town Co. v. Jaspar, 189 U. S. 439, 442, 47 L. ed. 892, 23 Sup. Ct. Rep. 571; Darnell v. Edwards, 244 U. S. 564, 568; P. U. R. 1917F,

64, 61 L. ed. 1317, 37 Sup. Ct. Rep. 701. It is true that its application has not distinctly arisen since the recent rise in prices, but it is not possible that it should receive much less than the return which the statute contemplated and which the can know when we shall recover. The question is a practical one and comes, I think, down to this: the plaintiff is faced with a condition which permits it to have general application and yet not cover this, its most glaring illustration.

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TECHNICAL PAPERS

THE ILLINOIS WATERWAY

By M. G. BARNES, M. W. S. E.*

Presented October 18, 1920

The Chicago divide and the Illinois valley is the site of the ancient outlet of the Great Lakes and from the earth movement now in progress, Professor G. K. Gilbert, U. S. Geologist, predicts that the Chicago outlet will be restored in about 2,500 years. The summit of the rock divide is about 7 feet above Chicago Datum (low water 1847) and only 30 feet above the rock floor of the Niagara River where it leaves Lake Erie, which is also about the same elevation as the bottom of the Chicago Drainage Canal. Prof. Gilbert's prediction probably will not be realized if the present state of civilization and engineering knowledge persists, as engineers may be able to control the situation by the construction of dikes as they have in China and Holland.

Illinois is the lowest in elevation of any of the interior states, and even lower than Kentucky, Tennessee or Arkansas. The actual average elevation of the State is only 53 feet above Lake Michigan. This low elevation carries a moderate climate well north and will make navigation possible in mild winters as far as Chicago. No other State offers better natural advantages for the development of an inland waterway system.

That a navigable connection between the Chicago and DesPlaines rivers is the most important and feasable link between the Great Lakes, St. Lawrence and the Mississippi River systems was first realized by Marquette, who on Aug. 1, 1674, first proposed a canal across the Chicago Divide. This divide was within the present city limits of Chicago near Kedzie Avenue. From 1808 to 1825 a canal across the Chicago divide was repeatedly advocated, among others by Albert Gallatin, Governors Clinton and Morris, of New York, President Madison and John C. Calhoun.

The State of Illinois took action in 1823, authorized canal construction in 1829, commenced work in 1836 and after overcoming many financial difficulties and changes in plans due thereto, the present Illinois and Michigan Canal was completed and opened in 1848. Its construction cost was $6,557,681.50. This canal provided a channel 6 feet deep, 48 feet wide in rock, 60 feet water surface and 36 feet bottom width in earth, with locks 110 feet long, 18 feet wide and

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6 feet deep on miter sills. Owing to insufficient maintenance work the origin dimensions are no longer available and the official regulations limit the size boats using the canal to the following dimension—length 102 feet, width water surface 16 feet, draft 4 feet 6 inches, and height above water-line 11 fe 2 inches.

The Illinois River below LaSalle proved to be too shallow during low-wat seasons and its improvement by locks and dams became essential. To insure 7 ft. navigable depth the State built a lock and dam at Henry which was con pleted in 1872 at a cost of $400,000 and another at Copperas Creek which w completed in 1877 at a cost to the State of $347,747.51. In 1899 and 1903 t Federal Government completed locks and dams at LaGrange and Kampsvil which carried to the Mississippi the channel improvement which linked the latt with the Great Lakes. These locks in the lower Illinois River were made 3 feet long and 75 feet wide. Since 1900 the Sanitary Drainage Canal has becor the lake level section of the waterway between Lockport and Chicago.

The economic influence of the Illinois and Michigan Canal was large responsible for the phenomenal growth in wealth and population of Chicago a the State of Illinois. The canal was also a commercial success and was of pa ticularly great benefit to the northern part of Illinois on account of its influen in maintaining low freight rates. In 1885 Canal Commissioner Brainerd es mated that it had saved the people of the State within reach of its service not le than $180,000,000 in freight charges. From 1860 to 1915 the freight tran ported was over 74,000,000 tons. Tonnage statistics were not kept from 18 to 1860. From 1848 to 1915 the gross expenses were $5,391,107, tolls co lected $6,631,007, and earnings from rentals, leases and privileges from 1898 1915, $333,511.

The further improvement of the Illinois Waterways has been the subject study and report by various bodies for over thirty-five years. Mr. George Wisner, U. S. Assistant Engineer, made a survey for the U. S. Engineer Cor in 1883. His report may be found in H. D. 134, 48th Congress, 1st Sessio The proposed improvements were to give seven feet of water from LaSalle Joliet, with locks of the same dimensions as those on the lower Illinois at estimated cost of $3,433,582. In 1888 Congress directed that survey, plans an estimates be made for a waterway between the Mississippi River and Lal Michigan not less than 160 feet wide and not less than 14 feet deep. Capt. V L. Marshall, Corps of Enginers, U. S. A., was in charge of this survey, whic was made by Mr. L. L. Wheeler, U. S. Assistant Engineer, whose report of th survey may be found in H. D. 164, 51st Congress, 1st Session. The estimat cost of the 14 foot channel was $48,282,763. An estimate of $26,888,153 w also presented for an 8 foot depth. Capt. Marshall subsequently reporte adversely on the proposed 14 foot channel and recommended an 8 foot channel preferable to the proposed improvement and as entirely adequate for commerci and naval purposes. For this report see H. D. 51st Congress, 2nd Session, Vo V., pp. 2449-2452. Again in 1904 Mr. J. W. Woermann, U. S. Assistant En gineer, made a survey of part of the Illinois River for the Ernst Board Engineers, his report being printed in H. D.263, 59th Congress, 1st Sessio The project reported upon by the Ernst Board was for a 14 foot depth fro Lockport to the Mississippi with locks 80 feet by 600 feet, the estimated co for which was $23,543,582. No further effective action has been taken by th Federal Government toward the accomplishment of this work.

The State of Illinois at the general election of November 3, 1908, authorized a bond issue of $20,000,000 for the purpose of obtaining funds with which to complete the improvement from Lockport to Utica and to construct power plants, and also amended the State Constitution so as to permit the expenditure of such funds for those purposes. Many plans and projects have been submitted for the carrying out of the wishes of the people as expressed at the general election referred to. The best known of these called for a canal to accommodate Great Lakes or ocean-going vessels, drawing not over 24 feet. This plan contemplated several power plants estimated to develop a total of 140,000 horse-power. The cost was found to be greatly out of proportion to the benefits that might be derived. A Board of Engineers from the U. S. Engineer Corps and one civilian engineer, appointed to investigate the entire project from the Lakes to the Gulf reported adversely on a channel designed for ocean and lake shipping and also upon the 14 foot project. The report of this board may be found in H. D. No. 762, 63rd Congress, 2nd Session, and papers discussing this plan were read before this society by James A. Seddon, Lyman E. Cooley and Isham Randolph, which papers with discussion appear in the August, 1900, number of the Journal.

A board of engineers appointed by Governor Dunne of Illinois studied the problem and advocated a waterway 8 feet deep with locks 45 feet by 250 feet in the clear. The State Legislature passed a waterway act in 1915 and appropriated $5,000,000 for the construction of this project. This act also prescribed in great detail the location for the waterway and in fact, was too specific in its location as it left too little latitude for the engineer to exercise his talents in behalf of the State. This project, like the present one, utilized part of the Illinois River and therefore required a permit from the Secretary of War. A request for such permit was returned without approval.

When Governor Lowden began his administration, a Constitutional Amendment permitted the expenditure of $20,000,000 for a waterway and a State law on the statute books called for the construction of a specific waterway which did not meet with the approval of the Secretary of War or the Chief of Engineers of the U. S. A., and in 1917, the writer was called upon to make an investigation and to advise as to the best proceedure to secure the desired results, viz:—a physical waterway which could be seen and traversed and about which a discussion as to plans, route, etc., would be out of order and out of date.

From the foregoing it may be seen that the plans previously proposed for this waterway are of two types only, viz:—First, the shallow draft type with small locks designed to accommodate the Western River Steamboat of the packet type and small tow and second,—the lake type with somewhat larger locks to accommodate the lake or small ocean steamship. The latter type has been the most popular in the public mind probably because the terms "deep waterway" and "Chicago, an ocean port" appeal to the fancy or pride of local enthusiasts. Such a project would doubtless have materialized years ago had it not been for the great expense.

In order to compete successfully with railroads the waterways must be of such dimensions that freight may be forwarded at such low rates that commerce will be again attracted to this means of transportation.

The economics of commerce on land or water has steadily demanded that freight be moved in larger and larger volumes as witnessed by the increasing size of freighters, freight cars and train loads. The first type of improvement would be a step backward, as locks of that type have already proved inadequate to the demands put upon them. Certain Monongahela River locks above Pittsburgh are now operated with three shifts, 24 hours per day, but cannot pass the waiting traffic fast enough. The Lake type provides for the necessary large volume, but requires depth, which is uneconomical for the construction and operating cost of the carrier and in the case under discussion ,to improve the Mississippi River to such depth entails a great cost of construction as well as prohibitive maintenance and operation costs entirely incommensurate with the benefits to be derived. Lake boats to be economically operated must be built to withstand storms and severe weather conditions, must he highly powered, relatively fast and heavily manned. Such boats could not regularly operate on a long river route where the possible speed is much slower on account of lockages and speed regulations for the protection of the banks. To meet the demand for large tonnage and economical draft there is but one solution and that is to provide for fleets of barges of relatively large horizontal dimensions propelled by power boats.

That the size of the cargo has a great effect on the cost of haul is shown graphically by Figs. 1, 2, 3 and 4 for fleets of barges of from 750 to 4,500 tons capacity. These results are based on the cost of vessels, labor and material prevailing in 1914. Referring to the curve for a six-mile speed, it may be noted that it costs 2.7 times as much per ton to haul a cargo of 750 tons as it does to haul a cargo of 3,750 tons. Similar results are shown for other speeds. As the cargo capacity decreases below the limits studied, the cost of haul per ton increases and very soon reaches a point where it is no longer advisable to ship by water.

The effect of size on steamships is equally impressive. On the Great Lakes during the past 25 years, cargo capacity has been increased from about 3,000 tons to 14,000 tons and the cost of haul has decreased from 1.5 mills to 0.6 mills per ton mile.

The Mississippi Valley has a great system of natural waterways approximating 15,000 miles in length, much of which has been improved piecemeal and locally, but has not yet been connected with the largest commercial and industrial centers. These streams cannot be economically improved to great depth. The Ohio River has been improved by a system of slack water navigation with locks 110 feet in width and 600 feet long and the channel is 9 feet depth so as to be standard with the low water depth in the Mississippi from St. Louis to the Gulf. With the present flow in the Sanitary Canal it will be possible to eliminate the present locks in the Illinois River and maintain a nine foot depth of open channel from LaSalle to the mouth of the river.

At the time the writer became actively interested in this improvement the various reports had apparently crystallized into three projects, popularly known as Projects I, II and III. Project I contemplated the improvement of the present Illinois and Michigan Canal throughout. Project II contemplated the improvement of the I. & M. Canal from Lockport to the junction of the DesPlaines and Kankakee rivers, near Dresden Heights and the improvement of the Illinois River from that point to LaSalle. Project III was for an all river route from Lockport to LaSalle.

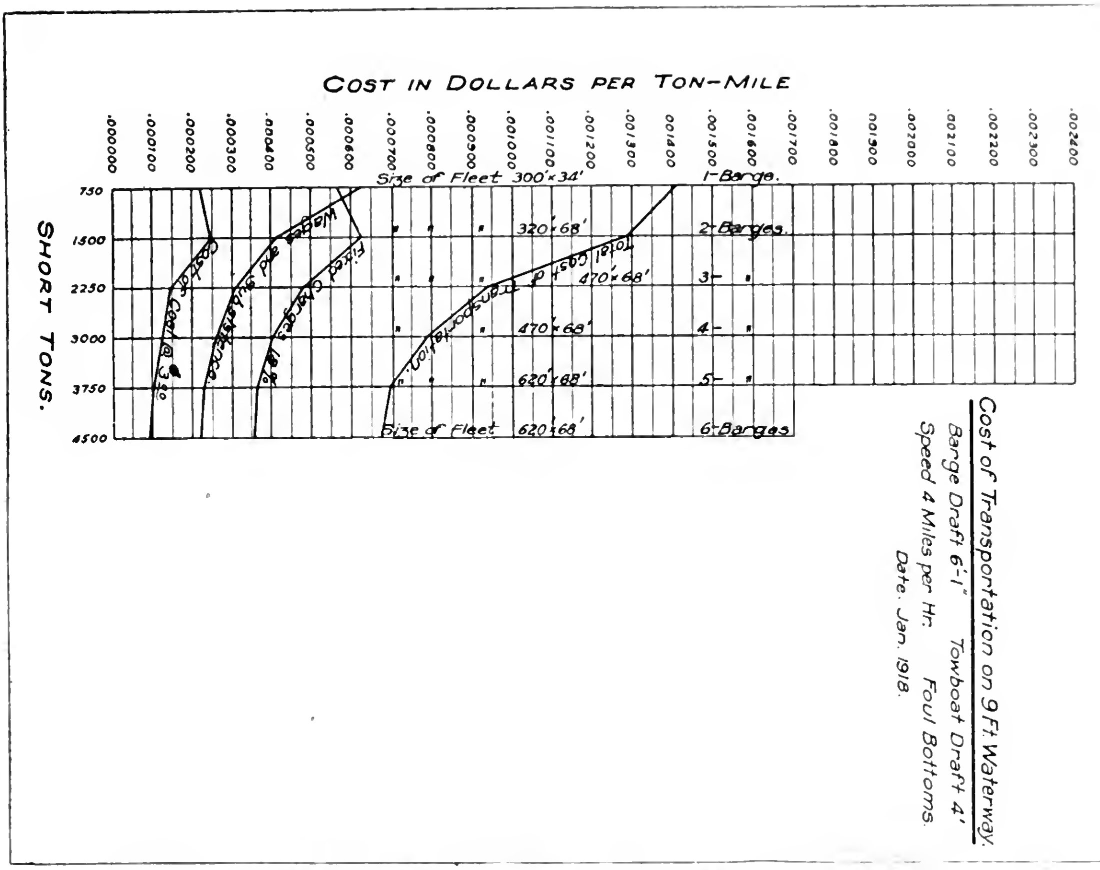


FIG. 1. Curves Showing Cost of Barge Transportation—Speed 4 M. P. H.

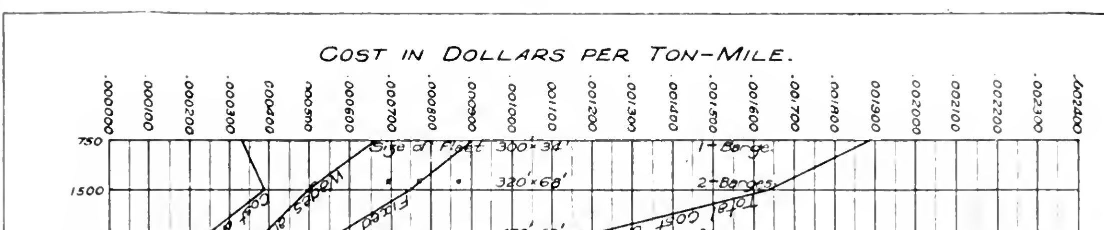


FIG. 2. Curves Showing Cost of Barge Transportation—Speed 5 M. P. H.

The main weakness of both Projects I and II was the limited capacity of the maximum channel which could be obtained. With locks 55x250 and a canal of 70 feet bottom width, the capacity would be approximately 12,000,000 tons and the estimated cost of construction per ton of capacity was 52 cents for Project I and 77 cents for Project II.

No water power could be developed under Project I and only 16,000 horse-power under Project II. Project III, the all river route, has no reasonable limitation as to capacity and about 60,000 horse-power can be developed from the flow of the river. The capacity and cost per ton of capacity for this project was estimated as follows: For locks 52x250, 12,000,000 tons at $1.18 per ton; for locks 75x600 feet, 40,000,000 tons at 43 cents per ton, and for locks 110x600 feet, 60,000,000 tons at 33 cents per ton. To provide for 60,000,000 tons on such an important link between two great waterway systems is reasonable provision for the future growth of water-borne commerce and as the Ohio River locks naturally fix the minimum horizontal dimensions which should be used on the Illinois Waterway, these dimensions have been adopted. However, a depth of 14 feet over the sills is provided for so that a future deepening of the waterway can be easily accomplished.

The Illinois Waterway is designed to connect Chicago and the Great Lakes system with the Mississippi Valley system. It extends from Lockport, the southern terminus of the Sanitary District Canal, to Utica, the upper limit of the improved Illinois waterway, as shown by the map on the opposite page.

In order to legalize and make possible the construction of the waterway in accord with the present adopted plan, the Legislature passed the 1919 Illinois Waterway Act, which provides that this waterway shall be at least 8 feet depth in earth, 10 feet depth in rock and be at least 150 feet bottom width, and that it shall be provided with locks 110 feet wide, 600 feet usable length and 14 feet of water over the miter sills at low water stages. The law also provides for the development of power from the surplus waters at all the lock sites except at Lockport, at which point power is already developed by the Sanitary District. This Act repealed the Waterway Act of 1915.

Last year application was made to the War Department for the approval of the general plans, which application was approved by the Chief of Engineers and the Secretary of War. An application for permission to develop the water power has been made in accordance with the recently enacted Water Power Act of the Federal Government.

Passing down stream the first work to be done is the construction of the lock at Lockport. Lake Michigan level is carried to this point through the Sanitary District Canal. The Lockport lock overcomes a lift of 41 feet, dropping the water to the DesPlaines River level. Inasmuch as it would be rather expensive to construct an emergency dam up stream from this lock to control the summit level in case of the failure of the lock gates, it is proposed to make the upper gates of this lock of the submerging type. There will be two such gates, each spanning the full width of the lock and so designed as to permit of their being raised against a head of water in case the mitering gates at the lower end of the lock have been carried away.

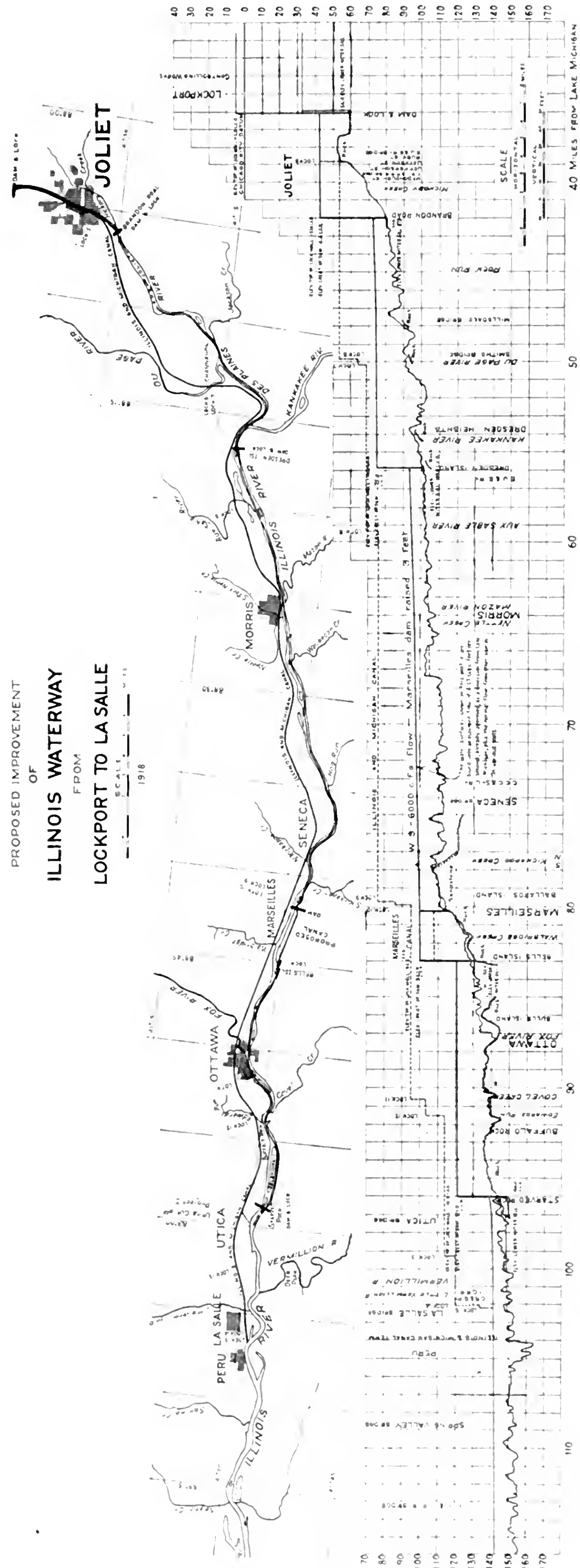


FIG. 5. Proposed Improvement of Illinois Waterway

The second lock will be built at Brandon Road at the southerly limits the City of Joliet. It will have a lift of approximately 30 feet, a long dam the gravity type and a power-house along side the lock. At this point conn tion will be made with the Illinois and Michigan Canal by a lock of the type the old canal structures.

The third lock will be located at Dresden Island, approximately one-h mile below the junction of the Kankakee and DesPlaines Rivers. This lock back water up both these streams and extend navigation up the Kankakee Ri for approximately five miles. The lift will be approximately 16 feet. dam will be provided with movable crest of the Taintor gate type. This p vision will permit of controlling the flood waters so as not to materially incre their height above former stages. A power-house will be located on the ri bank of the stream in this location.

The fourth lock is located at the lower end of a diverting channel appro mately 13,000 feet long, at Marseilles. Owing to the development of po interests at that point the present dam will be utilized, raising its crest appr imately 5 feet by the use of Taintor gates. This will divert water throug side-cut and create a head of approximately 21 feet at the lower end of the ca Water will be diverted through this canal for power purposes as well as navigation.

The fifth lock will be located at Starved Rock. It will have a lift of proximately 16 feet and will drop the water into the improved channel at t point. This lock will be located below the mouth of the Fox River and the d must be of sufficient spill-way capacity to accommodate flood waters at this po which in the past reached a total of 80,000 c. f. s.. feet. The dam will be of Taintor gate type, there being 11 gates each 60 feet long and 17 feet high exc one which, will have a height of only 5 feet, it being designed to pass ice, fl trash, etc. A large power-house will be installed on the north bank of the ri at this point.

BRIDGES.

It will be necessary to re-construct several existing bridges along the line this waterway and one new bridge will be required at the Marseilles Canal. Brandon Road lock will raise the water to very nearly the lower chord of brid through Joliet. This will necessitate some type of movable bridge for both hi ways and railroads at this location. The waterway through the city must be least 270 feet wide to comply with the law. It is proposed to bridge this w one fixed span and one movable span. Designs for these bridges have not been completed. In the pool above Dresden Island it is probable that one n bridge will be required to replace the old one known as "Smith's Bridge." T probably can be of the fixed type. No bridges will be required between M seilles and Dresden Island. It may be necessary, however, to modify some of existing bridges, raising them and protecting against collision from passing bo The clear head-room under the bridges is a question yet to be determined. Hennepin Canal has a clearance under fixed bridges of 17½ feet. Many of steamers on the Mississippi River system require a head-room of 35 feet. If th steamers are to be accommodated in the Chicago River and commerce becom what we hope it will be, it will be very difficult to use the bridges within the c limits for highway purposes as they would be constantly raised to pass steam The question of type of bridge and steamer is therefore an important one and requiring immediate consideration and decision.

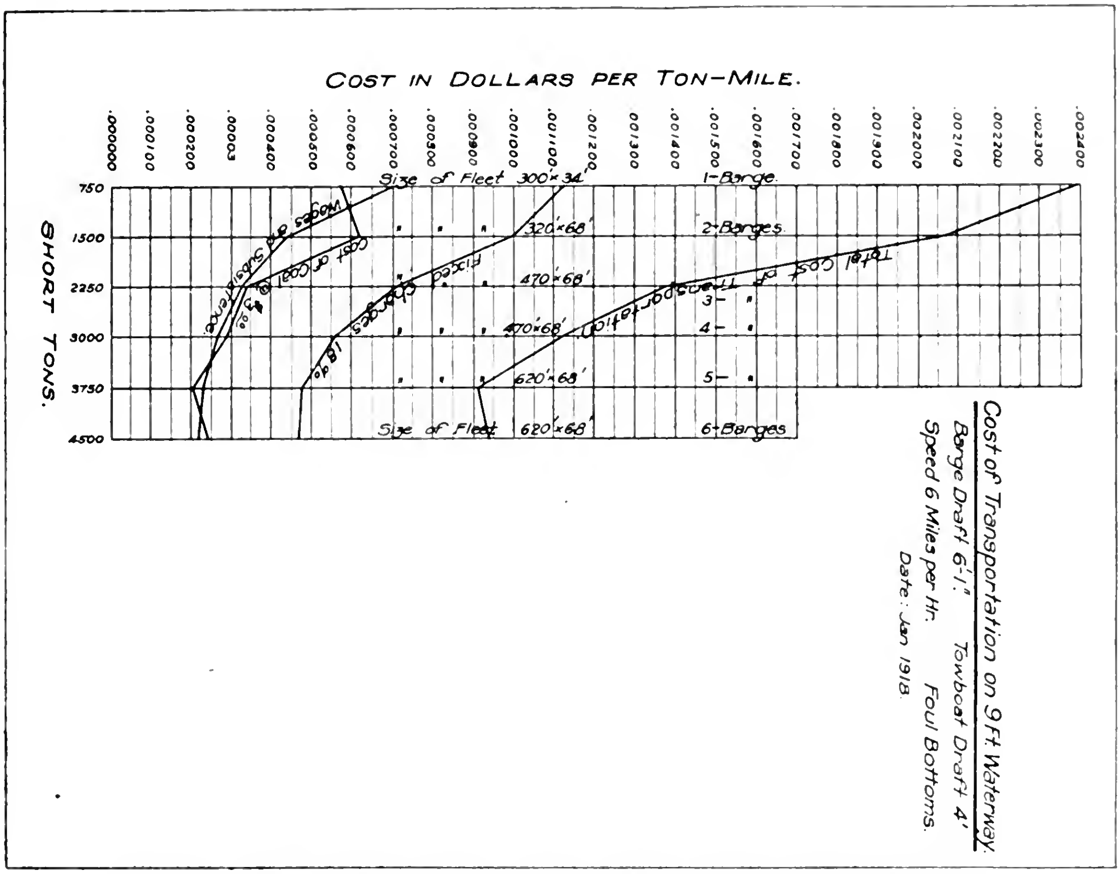


FIG. 3. Curves Showing Cost of Barge Transportation—Speed 6 M. P. H.

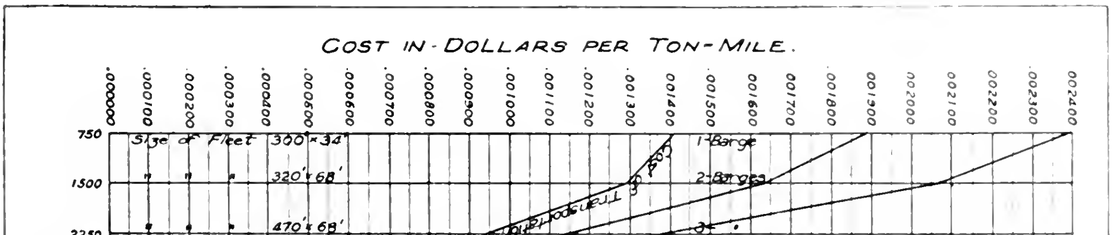


FIG. 4. Curve Showing Cost of Barge Transportation, Varying Speeds and Loads.

CHANNEL EXCAVATION.

The location and elevation of the locks is such as to require a minimum of channel excavation, the principal amount being at the lower end of the locks and in the Marseilles cut-off. There will probably be in the neighborhood of a million yards or possibly a little more of river excavation, most of this being glacial drift. The Marseilles Canal will require an excavation of 1,500,000 cu, yards. This is largely shale.

WATER POWER.

The law provides that the State may construct power plants and lease the output for a term not exceeding 30 years, or it may lease the water under a head, the lessee constructing the power plant which may be purchased at the expiration of his lease for a term not exceeding 30 years. When this power is all developed there will be available approximately 60,000 electric horse-power. Its use will result in an annual saving of more than 600,000 tons of coal and will relieve thousands of cars and locomotives for other and more profitable uses.

In the design of steelwork for lock structures the specifications of the American Bridge Company have been adopted with the further limitation that no material less than 3/8 inch thick should be used. The maximum allowable compressive stress on concrete, except for embedded steel bearing pieces is 300 lbs. per sq. inch. Reinforced concrete is designed according to the requirements of the American Engineering Societies' Joint Committee on concrete and reinforced concrete design.

All lock structures will be founded on rock.

The side walls of locks are to be of the retaining wall gravity type of mass concrete with vertical and battered back and have a 12 ft. diameter filling and emptying culvert located near floor level with lateral openings directly into the lock chamber. The filling system as adopted for the Soo and Panama locks viz: by culverts under the floor with vertical openings into the lock chamber was considered but investigation and inquiry developed that this system possessed no material advantage and would cost about $25,000 per lock more than the system for filling through horizontal openings from the main culvert. These lateral openings have been so spaced that when filling the locks the longitudinal drift of a boat will be toward the center of the lock chamber and away from the gates.

The stress analysis of the side-walls with culverts was made according to a modification of the "Least Work" method as described by Walter M. Smith, Designing Engineer on this work, in articles on this method of investigation of arched structures in The Engineering Record of October 10, 1914, and May 22, 1915, as this method is believed to be the most accurate method of determining stresses in a wall containing a large circular culvert.

The valves for the filling system are of the vertical lifting type and for such valves the past custom has been to make the valve chambers and openings of as large or larger area than of the main culvert. For these locks, however, advantage has been taken of the "Venturi" principle of the flow of water through contracted openings which resulted in the adoption of valves 9 feet square with a consequential saving in the cost of valves and valve machinery. Tests of valve openings constructed on this principle have shown a coefficient of discharge of 1.32 for a 28 ft. head of water. However, in these designs a coefficient of 1.15 has been assumed.

It was assumed that the change in water level would be limited to 4 feet per minute and under this limitation the maximum velocity in the main culvert will be about 22 feet per second and in the smaller valve opening about 30 feet per second. The maximum loss of head will be about 10 per cent or 9 inches for these valve openings and the loss will rapidly decrease as the lock fills.

With this design and the 4 feet per minute limitation, the time of filling or emptying a lock will range from 7 to 12 minutes, depending upon the lift or head and the combined time for filling all five locks will be about 44 minutes.

Concrete floors for the locks will be constructed only where such are deemed necessary to prevent erosion of the rock.

The type of approach walls for the locks will depend upon local conditions. At Marseilles no lower approach wall will be built as the rock surface is high enough so that a channeled rock face will suffice to moor boats against, while awaiting lockage. The upper approach wall will be re-inforced concrete bridge type with piers on 20 feet centers. At Starved Rock the probable ice conditions indicate the advisability of massive concrete piers on 120 foot centers in lieu of a continuous approach wall and such construction has been adopted.

Ice conditions on this waterway are unique and require careful consideration in the design of structures which will be affected by ice, particularly such structures as must be operated in cold weather.

The flow in the waterway is from North to South, but as much of the flow is used by Chicago for domestic, manufacturing and sewage purposes we have a condition of relatively warm water flowing down the waterway to be cooled by the air, and water from tributary streams. This results in the formation, during freezing weather of continuous fields of floating ice which under the present unimproved condition of the river has resulted in huge ice gorges, destructive to property by reason of the flood water backed up by these gorges. After the waterway is in operation, it is believed that the discharge at the dam can be so regulated as to prevent serious ice gorges.

With the exception of the upper gate at Lockport all lock gates will be of the horizontally framed mitering type. These gates have the same horizontal dimensions as those on the Panama Canal, but will differ from the latter in some important details. They will in general, have a single skin on the down-stream side, but the lower gates at Lockport and Brandon Road will have a double skin for the bottom 15 feet to form an air-chamber to secure bouyancy for the reduction of bearing stress on the pintle and the yoke pin.

Heretofore the design of lock gates and miter-sills provided for the gate leaves bearing against the miter-sills to prevent leakage. This necessitates a design for miter-sills on the assumption that the sill might be subpected to two-thirds of the total water pressure on the leaf, and the gate leaf had to be designed to take care of the deflection of vertical members and the stresses developed therein.

In the Illinois Waterway designs this uncertainty as to stresses has been remedied by making the water seal along the lower edge of the gate by means of a bronze spring which alone is in contact with the miter-sill when the gate is closed and which cannot transmit to the sill more pressure than that due to the water in contact with the spring. This results in a material saving in the cost of both gate and miter wall. The miter walls are designed as horizontal arches instead of the usual gravity type of retaining wall design.

The valves in the culverts will be 9 feet square of the vertically rising type, without counterweights, and will be raised by chains. These valves will be equipped with roller bearing wheels to reduce the friction due to wate rpressure. In the past, valves of this type have been designed to bear against trains of live rollers of the Stoney sluice gate type, but the improvements in roller bearing design now permit their use for such purposes.

Movable dams and crests of dams will be Taintor gates, these being the most economical and possessing the advantage of being more sure in operation under ice conditions. The Taintor gates for the Starved Rock dam will be 17 feet high by 60 feet long, these gates being longer than any yet constructed.

All machinery will be electrically operated and the miter gate machinery will be on the so-called Bull wheel type invented by Edward Schildhauer, a Chicagoan, for the Panama Canal. This machine permits of a constant speed motor giving a variable speed to the gate which is highly desirable. A description and cuts of this machine may be found in the September, 1914, number of the Journal of this society as part of a paper read by L. D. Cornish, who is now the Assistant Chief Engineer of The Illinois Waterway.

Chicago, the third largest city in the world, will lie at the junction of the two greatest inland water systems of the world when the connecting link, The Illinois Waterway, is completed. Will Chicago and the State of Illinois benefit by the linking of these great waterway systems? Can anyone doubt it, when it is so easily shown that water transportation in large bulk is the cheapest in the world, and statistics show: that 56 per cent of the area of Illinois and 70 per cent of its population are within 25 miles trucking distance of this waterway and its connections; and that this area produces annually 250,000,000 bushels of grain and originates 125,000,000 tons of freight; and that in 1917 the total manufactures of Chicago amounted to $2,464,240,250, its wholesale trade exceeded $3,000,000,000 and that these items respectively approximated 50,000,000 and 60,000,000 tons; and that Chicago consumes annually 30,000,000 tons of bituminous coal, which consumption is increasing at the rate of 1,000,000 tons per year; and that Chicago is the distributing point for at least 6,000,000 people, and is the junction point of the railroad systems of the Middle West over which upwards of 200,000,000 tons of freight are transferred in the Chicago district.

The Morton Salt Company, of Chicago, tested out the possibilities of inland waterway transportation in 1912, 1913 and 1914 and the results attained have made this company enthusiastic on the subject of the early completion of The Illinois Waterway.

This Company purchased the only three survivors of the big fleet which once navigated the Illinois and Michigan Canal. These were the steamboats Peerless and Niagara and a barge all over 40 years old and in such poor condition that the pumps had to be kept going all the way on the first trip to keep them afloat. Two of these boats were fished out of the bottom of the Illinois River to be put into this service. The capacity of the boats was 150 to 175 tons but owing to the shallow water in the Illinois and Michigan Canal their average load was limited to about 97 tons per boat. During the three seasons these boats, loaded for 79 per cent of their travel, actually carried 9,134 tons, an average distance of 162 miles at a cost of $1.806 per ton or 11 mills per ton mile. If there had been an available draft of 4′8″ in the Illinois and Michigan Canal these boats could have carried 150 tons per trip and the cost would have been 7 mills per ton mile.

The log of the Peerless on her first trip shows that she averaged only 16 miles per day of 12 hours on the Illinois and Michigan Canal with 11 locks to pass, whereas her average on the Illinois and Mississippi (Hennepin) Canal, with 32 locks was 38 miles per day of 12 hours. Her speed in the Drainage Canal was 8 miles per hour.

The results shown by this experiment surely indicate that with modern boats and barges of much larger capacity and a modern waterway the cost of haul can be lowered to a figure that will make waterway transportation very attractive to private capital and result in the annual saving of millions of dollars to the producers of Illinois and other states.

Several agencies have operated to put the Illinois and Michigan Canal out of commission. As noted herein, it once accommodated very important traffic and was of invaluable service to the people of the whole State. Built with public funds it was a public benefit and continued so until after what an Illinois Congressman once designated as the "crime of 1870." In that year Illinois adopted a new Constitution in which railroad interests wrote a clause prohibiting the State from lending its aid to building or maintaining waterways. Immediately upon its adoption the Rock Island railroad put its summer rates below the canal rates, only to be increased during the winter months so as to recoupe the road. This procedure soon attracted the freight from water to rail and with the consequent lessening of tolls, the canal went into disuse. This, of course, was not the only reason the canal went into disuse, but it was a most important contributing cause. The transportation charts accompanying this paper show conclusively that for modern business the canal was altogether too small to successfully compete with such a hostile enemy. Had its dimensions been increased in keeping with the demands of commerce the results would have been different. Moreover, the railroads were equipped with up-to-date depots and terminals for the accommodation of the public. Contrast on one hand a boat landing at a canal bank or at the foot of a steep river bank with a shipper standing guard over his goods in all sorts of weather waiting the arrival of the boat; no one to receive his goods; no place to shelter himself or goods; the ensemble dark, gloomy, forbidding. On the other hand, a well-appointed freight depot in which to store his goods. An important street with easy grade over which to haul his goods. An accommodating agent to receive, receipt and become responsible for the safe shipment of his goods. Tele-

phone connections, telegraph accommodations and last, but by no means least, an active traffic agent soliciting his business. In a word, the contrast between a publicly owned and privately owned transportation line. It is this very condition that must be overcome before waterways become the success they merit. Inherently transportation by water is the cheaper and will always remain so. The roadbed costs no more. A man can tow a loaded barge through quiet waters, but it requires a horse to pull an empty car over a level railroad. The cost of upkeep for track and equipment by water is much less than by rail. The cargo or fleet capacity of the proposed Illinois waterway and the connecting rivers of the Mississippi Valley are from 7,500 tons upwards, while the average trainload on the railroads is less than 600 tons and their maximum trainload about 3,000 tons.

Transportation on the inland waters of the United States is being conducted at from 80 per cent to as low as 10 per cent of the cost by rail. The Federal Government's barge service is hauling Chicago freight from New Orleans to St. Louis, shipping thence to destination by rail at an average saving of better than $4.50 per ton. If the Illinois Waterway were completed and the Illinois and Mississippi rivers deepened to 9 feet at low water from Utica to Cairo, the saving would be from $6.00 to $10.00 per ton and even more on some classes of freight.

A system of waterways may almost be likened unto a chain—the whole no stronger than its weakest part—not quite true but nearly. The Hennepin Canal begins somewhere on the Mississippi River and ends in a swamp on the Illinois River. It never will be of much consequence until connected with important freight centers. The Illinois Waterway will not reach its greatest usefulness unless and until the Illinois and Mississippi Rivers are improved to a 9 foot depth and the various shipping centers are properly equipped with freight handling and storing accommodation. Let waterway advocates keep constantly before them the contrast between rail and water accommodations. The success of waterways is a direct function of these factors. The nearer we approach railroad facilities, the greater will be our measure of success. Fundamentally, waterways have the advantage in many particulars. It remains for American ingenuity and a sane business policy to make our natural inland waters the most potent factor in the country's future prosperity. Shall we profit by the natural advantages a kind Providence has given us—a natural system of waterways reaching to the very heart of our country? The voice of a progressive and aggressive people will answer.

I recently read a paper on the subject of terminals before the Association of Port Authorities of North America. There are no water terminals in Chicago. That may be putting it rather strongly, but as to modern terminals, Chicago is woefully lacking. The Chicago River, between Chicago Avenue, on the north, and Twenty-Second Street, on the south, is three-fourths owned by railroads and occupied by them. I am not saying this in criticism, but as a fact. Most of the balance is owned and occupied by private warehouses and private corporations, again not for criticism, but it is a condition that exists.

St. Louis is beginning to overcome that. Up to within a year they had no terminals. Now they are building a new modern terminal that is attracting considerable business to St. Louis. Your Chicago freight is being hauled from New

Orleans to St. Louis by water, thence by railroad to Chicago and there would be more of it if the terminals were completed.

They state that they are hauling it now at a saving of $4.50 per ton on third class freight, and all space for this season is contracted for. In order that Chicago may take advantage of this waterway there must be built a very important system of terminals. I doubt if this system will be in the city proper. My own feeling is that it must be outside the city. All freight that is not destined for the city of Chicago must be kept out of the congested area. The streets now are congested by automobiles, street cars, and surface traffic generally, and to bring freight into this congested loop district is to make matters worse.

In the article previously referred to I suggested the important terminal be located in the Calumet district. If you will picture, in your mind, a map of the city you will observe fourteen important railroads meeting near Lake Calumet, all the railroads running to the south, east, southeast and around even to the west, including the Rock Island, meet in that locality; 79 per cent of the freight transferred in the city of Chicago is transferred at that location. This immediately suggests the question—why not locate the barge terminal where the railroads are? The barge lines, both the lake and Mississippi River system, will serve the same district, and can meet in that same locality.

Another district that appeals to students of terminal facilities is the district reached by railroads running to the north and west, joined by the existing belt lines in the city. We find such a district on the west fork of the South Branch of the Chicago River and the Sanitary District Canal. Between these two waterways there is a large area that can readily be made into a very important terminal for use by all the railroads of the Northwest, and if joined to the loop district by an adequate tunnel, the commercial district would be served without bringing the boats or rails within the loop. I don't mean by that to abandon the use of existing waterways, or existing rivers. They should be used to capacity. Industries could be attracted to them. But as noted in my terminal article it is questionable whether we can attract important business to this river, because of the bridges. Mississippi barges require 35 ft. head room and lake boats require 90 ft. If we are to use the Chicago River as actively as we hope, we simply cannot use it for street purposes. So, in short, what we must do in Chicago is to develop adequate rail and water terminals combined in the Calumet District and in the district along the West Branch of the South Fork of the Chicago River, with a small passenger transfer station at the city's gate.

It always seemed to me that the proper place for passenger or excursion boats is at the city gate and that commerce, industries and manufacture should be kept back where they would be out of the way of the highly congested street traffic.

The question of the flow from Lake Michigan was very carefully gone into with the Federal Officers before Judge Landis had rendered a decision. Federal engineers do not recognize the flow that passes down the Illinois River from Lake Michigan, and have not for some time. There is a temporary permit issued by the Secretary of War, allowing a diversion of 4,167 c. f. s. from Lake Michigan into the Desplaines River. Actually there are 8,000 to 8,500 c. f. s. flowing into

this river. When we were in conference with the Chief of Engineers, the Secretary of War and Judge Advocate General, that matter was thoroughly gone into with them, as a matter of fact, we had taken that into account before we went to Washington with our plans. The locks are all located just as I would locate them, whether there were 4,167 c. f. s. or 14,000 with possibly one exception. If we knew that the river would not have more than 4,167 c. f. s. from Lake Michigan, or that even that amount may be taken away, we would probably install one more lock on the reach between the junction of the Kankakee and Desplaines Rivers and Marseilles. However, all the locks are so located, and their copings and miter sills so planned, that no matter what the flow from Lake Michigan, we will have the depth required by low, i. e. 10 feet in rock, 8 feet in sand and 14 feet on miter sills.

If, in time, the diversion from Lake Michigan is taken away from us, we will still have that depth, by increasing the height of the dam at Marseilles or by taking out an additional amount of excavation below the Dresden Island Lock, or both.

However, we have a condition here before us that is not easy to overcome; to limit the flow from Lake Michigan to 4,167 c. f. s. would mean a calamity to this district, until some other system of securing sewage disposal purification is installed. No matter what Judge Landis has decided, we have a physical condition before us that is a serious one, one that we all recognize, even Mr. Sherman recognized it as long ago as when he was in office, and to limit the flow now to 4,167 would be a calamity, not on Chicago alone, but on the whole State. It is my judgment that before the diversion can be reduced to 4,167 c. f. s. a great deal of this work will have outlived its usefulness. We may want new and longer locks and new designs by that time.

As to the current in the waterway from the lower Illinois River, there is an average slope of 13-100 of a foot per mile, and the velocity is so slight that it requires an object thirty days to float from LaSalle to the mouth of the river. The accompanying table from the Second Annual Report of the Diversion of Waterways, Department of Public Works and Buildings, shows the computed velocity of water, in the Marseilles pool from the junction of the Kankakee and Desplaines River down to Marseilles, a distance of about 25 miles..

TABLE OF VELOCITIES IN MARSEILLES POOL—ILLINOIS WATERWAY

Station.	Crest raised 3 feet				Crest raised 4 feet				Crest raised 5 feet				Crest raised 6 feet			
	4000	6000	8000	10000	4000	6000	8000	10000	4000	6000	8000	10000	4000	6000	8000	10000
1306	0.5	.07	1.0	1.2	0.4	.06	.09	1.1	0.4	.06	0.8	1.0	0.4	0.5	0.7	1.0
1309	0.5	0.8	1.0	1.2	0.5	0.7	0.9	1.1	0.4	0.6	0.9	1.1	0.4	0.5	0.7	1.0
1315	1.0	1.5	1.9	2.1	0.9	1.2	1.6	1.9	0.7	1.1	1.4	1.7	0.6	0.9	1.2	1.5
1320	0.9	1.4	1.8	2.2	0.9	1.2	1.6	1.9	0.8	1.1	1.5	1.7	0.7	1.0	1.3	1.6
1326	0.6	0.9	1.1	1.3	0.6	0.8	1.1	1.3	0.5	0.7	1.0	1.2	0.5	0.7	0.9	1.1
1335	0.7	1.0	1.3	1.5	0.6	0.9	1.2	1.4	0.6	0.8	1.1	1.3	0.5	0.8	1.0	1.3
1345	1.0	1.4	1.8	2.0	0.9	1.3	1.6	1.9	0.8	1.1	1.5	1.8	0.7	1.0	1.4	1.7
1355	0.8	1.1	1.4	1.7	0.7	1.0	1.3	1.6	0.7	1.0	1.3	1.5	0.6	0.9	1.2	1.4
1365	1.0	1.4	1.7	2.0	0.9	1.3	1.6	2.0	0.8	1.2	1.6	1.8	0.8	1.1	1.5	1.8
1372	1.0	1.4	1.6	1.9	0.9	1.2	1.6	1.8	0.8	1.1	1.4	1.7	0.7	1.1	1.3	1.6
1376	1.2	1.7	2.0	2.2	1.1	1.5	1.9	2.1	1.0	1.4	1.7	1.9	0.9	1.2	1.5	1.8
1379	1.0	1.4	1.8	1.8	0.9	1.2	1.7	1.7	0.8	1.1	1.5	1.6	0.8	1.0	1.4	1.6
1389	0.9	1.3	1.5	1.7	0.9	1.2	1.5	1.7	0.8	1.1	1.4	1.6	0.8	1.0	1.3	1.6
1399	1.2	1.7	1.8	2.0	1.2	1.5	1.8	2.0	1.0	1.3	1.7	1.9	0.9	1.3	1.6	1.8
1409	1.2	1.6	1.9	2.1	1.2	1.6	1.8	2.0	1.1	1.4	1.7	1.9	1.0	1.4	1.6	1.9
1419	1.4	1.7	2.0	2.1	1.3	1.7	1.9	2.1	1.2	1.6	1.9	2.1	1.2	1.6	1.8	2.0
1429	1.3	1.5	1.9	2.1	1.2	1.5	1.8	2.0	1.2	1.6	1.8	2.0	1.1	1.4	1.7	2.0
1434	1.5	1.4	1.6	1.7	1.4	1.4	1.5	1.7	1.2	1.3	1.5	1.6	1.1	1.2	1.4	1.6

The crest raised five feet is approximately what we have designed for, and the highest velocity found on any section in that 25 mile reach is 2.1 feet per second, with a discharge of 10,000 c. f. s. That is approximately the summer discharge. We are making an improvement of this river calling for five locks, and there is very little excavation to be done. The locks are so designed as to raise the rivers and create pools covering most of the reach to be improved. I believe you will not find a stream in the United States, Europe or any other country better than the Illinois River for navigation purposes. It is of ample width, the curves are gentle, and there is ample water for any traffic that will ever use the river.

As to navigating during the winter,—of course the waterway will be closed during some of the winter months. You must also remember, as outlined in the article that we are sending a large amount of warm water into the river from Chicago and this tends to keep the river open late in the fall and open early in the spring. Since I have been in Chicago the river has been open in the latter part of February and frozen over in December. If I were contemplating using the waterway myself I think I should plan on at least three months of closed season. There will be years, however, when the waterway can be kept open practically all the year. The cost curves accompanying the paper show the cost of barge transportation per ton mile.

The cost per ton mile on water transportation shown by the curves should be applied to the water distance. To compare with railroads you must properly take into account the distance by water and the distance by rail. We are working on a three-year schedule. The first project for which a contract will be let calls for completion in two years. The next project we are putting on a thirty-six months' period, and we are in hopes to so plan all of the work that it will be completed by that date.

On the subject of traffic some statistics taken from a report of the Department of Commerce on the increase of traffic and transportation on our inland waters are shown herewith:

	1889	1906	1916
Lower Mississippi River Freight (tons).........	6,232,087	9,164,007	11,635,983
Lighterage and Harbor Work (tons)...........	169,116	2,354,051	3,167,890
Upper Mississippi River Freight (tons).........	6,260,448	1,758,101	754,451
Lighterage and Harbor Work (tons)...........	679,892	482,090	1,658,027

This, you will notice, shows a very decided increase in the business on the Lower Mississippi. Of course, that is not all through business. Most of it is local business, transferring across the river, or from one town to the next town on the stream. Through business on the Mississippi has declined, we all know. And we also know the reason for it; the reason why it is unprofitable to haul by water on the Upper Mississippi before the recent increases in freight rates. If you will refer to the excerpt from the report of the Chief of Engineers for 1919, page 1265, you will find that on the Upper Mississippi, where they have been working on the project since 1910, there are only 22 miles that have the 6 foot depth, and at low water season boats must load to accommodate themselves with 3½ to 4½ foot depth. This, with the small capacity of the locks and the dangerous channels, makes the labor cost per ton too high to compete with the railroads. However, with the new rail rates commerce, undoubtedly, will increase on the Mississippi River and I presume that it is already doing so, and will continue to increase on the Lower Mississippi. One of the managers of a Missis-

sippi River service tells me they have all the business they can handle. It is not a question of getting the freight. It is a question of getting the boats to handle it.

The State does not contemplate terminal facilities. We are limited by the constitution, and it is up to the waterway towns to take care of the terminals to get them finished. We will not have the full benefit until we have proper terminals. Several questions have been raised that indicate considerable interest as to the relative cost of transportation by rail and water.

EXCERPT FROM REPORT OF CHIEF OF ENGINEERS FOR 1919.

Sections.	Length of Sections Miles.	Controlling Depth in Feet, 1918.
St. Paul (Omaha bridge) to Prescott	29.7	3.5
Prescott to foot of Lake Pepin	47.6	4.2
Foot of Lake Pepin to Alma	10.7	5.0
Alma to Genoa	74.3	5.4
Genoa to Wisconsin River	51.0	5.2
Wisconsin River to Rock Island Rapids	134.8	5.3
Rock Island Rapids	14.7	4.0
Rock Island to Keokuk	121.8	4.9
Keokuk to Hannibal	56.1	4.2
Hannibal to Illinois River	94.5	4.5
Illinois River to Missouri River	22.8	7.0
Total	658.0 miles	

Concerning the Monongahela Locks being too small. In the fiscal year of 1919, on an improved reach of the Monongahela River, 60 miles long, and which cost $12,000,000 for the improvements there were 17,000,000 tons of freight handled on the water, at a saving to the shipper of $12,000,000.. The river rate for that tonnage was 2.15 mills per ton mile and the rail rate was about 13 1-3 mills per ton mile. The traffic is growing so fast that the government is now considering either doubling the length of the locks or else building twin locks because the locks now in use cannot handle the present possible traffic.

The peak of that congested period was during the time in which there was such a general coal shortage, due to railroad traffic congestion of the mills being shut down in Pittsburgh.. If it had not been for that 60 miles of waterway, 90 per cent of the steel mills in the Pittsburgh district would have had to close down because the railroads could not deliver coal to them.

In this article we did not go into the question of commerce to any great extent. I did not realize it was going to be as interesting a subject as it has proven to be. We were addressing ourselves to the engineering features of the waterways. That might be a subject for some one to talk on for a whole evening.. It is a very important subject, and it is one that waterway advocates know, and we all know, that in this district there is no question at all of the amount of tonnage available. The railroads of the United States can draw traffic from an average of only 4.7 square miles, per mile length of the roads, but they are obtaining between 18,000 and 19,000 tons per mile of road, or approximately 4,000 tons per square mile of area they serve. There are something like 30,000 square miles of territory in the state of Illinois within 25 miles of the railroad, and auto trucks can haul a distance of 25 miles, and beat the railroads at cost per ton mile, to say nothing about the saving in loading and unloading.

If the amount of tonnage along the river is the average of the tonnage throughout the state of Illinois, there are over 150,000,000 tons within trucking distance of the waterways of the state, so there is no question of tonnage available. My idea is that the facilities for handling, receiving and caring for water borne freight should be equal to the facilities possessed by the railroads, if we can equal the railroads in those things we are going to have more business than we can handle, and we are going to handle it at less than half of what the railroads can do it for, no matter how they try.. Their rates are increasing and have doubled in the last five years. The water rates have not yet found their bottom, and as we increase our facilities we are going to lower the rates. If I had known this paper was going to be of such interest we might have touched on the terminal and transportation question at greater length.

HIERO BENJAMIN HERR
1842-1920

HIERO BENJAMIN HERR was born in Lancaster County, Pa., Nov. 12, 1842, and passed away Sept. 3, 1920, at Dillsburg, York County, Pa.

He was the son of Benjamin G. Herr and Mary Emma Witwer. His father was an ardent student of history and languages and served several terms in the Pennsylvania legislature. His mother was a lineal descendant of Dr. Benjamin Rush, one of the signers of the Declaration of Independence.

At the age of 19, the subject of this memoir won a cadetship in a competitive examination and entered the U. S. Military Academy at West Point, where he graduated with honor four years later, June,, 1866.

After a year's service at Fort Trumbull, New London, Conn., he was recalled to West Ponit to become assistant to the head of the Department of Mathematics. He remained there until 1870, when he resigned from the faculty of the military academy and gave up his lieutenant's commission in order to accept the chair of mathematics and astronomy at Lehigh University, Bethlehem, Pa., which he held for four years.

While at Lehigh University, Mr. Herr took up the study of mining engineering and when he resigned his professorship in 1874, it was to become superintendent of a group of silver mines in Colorado. He soon acquired a reputation as a mining expert and was entrusted with many important examinations of gold, silver and diamond mines in the West and in South America.

Later, he entered the Government service, and had charge of engineering parties in the South for four years. The first survey for the location of the proposed Missisippi and Illinois (Hennepin) Canal was made under his direction in 1882. That same year he left the Government service and engaged in busines in Chicago, his initial undertaking being the construction of a breakwater along the lake front on the present site of Grant Park.

The class-room again called to him in 1883 and he went to the University of California to head the Department of Civil Engineering, but returned to Chicago the year following and established the engineering firm of Hiero B. Herr & Co.. which he carried on until 1895. From 1895 to 1900 he was president of the Star Construction Company. In later years he built up a practice as consulting mining engineer, but failing eyesight compelled him to relinquish this and in 1919 he and Mrs. Herr moved from Evanston, Ill., to Carlisle, Pa., to be near their daughter. Here a combination of outdoor life and rest brought him renewed vigor and his sudden end came as a great shock to his family. Apparently in the best of health and spirits, he lay down for his usual afternoon nap and smilingly wandered into a dream-land from which he never returned.

Mr. Herr was a member of the American Institute of Mining Engineers, the Chicago Engineers' Club and the Western Society of Engineers, of which he was president in 1894.

He married Miss Martha A. Shenk, of Lancaster, Pa., June 25, 1868 The widow and a daughter, Mrs. W. S. Russell, Dillsburg, Pa., survive. A son, Percy, a young lawyer of great promise, died in 1901, a lasting sorrow to Mr. Herr.

In June, 1916, Mr. Herr, with the eleven other surviving members of the West Point class of '66, General Charles King, the soldier novelist, and ex-Governor Upham, of Wisconsin, among the number, celebrated the fiftieth year of their graduation. Mr. Herr makes the third to drop from the ranks since that anniversary.

To his intimate friends and business associates, Mr. Herr leaves the memory of an upright character and an unfailing courtesy that survived all the triumphs and adversities of a long business and professional career. He was a true gentleman of the old school, a type too seldom met in these days of ruthless grasping for material wealth.

J. A. SAUERMAN.
E. C. SHANKLAND.
L. E. RITTER.

May, 1921

DEVELOPMENT OF AIR RIGHTS IN CONNECTION WITH CITY FREIGHT HOUSES*

By E. J. Noonan**

In the past few years students of railroad questions have given considerable thought to the possibilities of economics in the operation of city freight terminals and a great deal of this thought has taken form in the suggestion for a more intensive use of the valuable real estate occupied by the railroads near the business centers of our principal American cities.

In the City of Chicago, in the district immediately south of the central business district, the property used for railroad freight house purposes has been estimated to have an average value of $20.00 per square foot.

In this same district, on the basis of the area used per car standing capacity, figuring interest at 6 per cent, the interest charge on the property used would amount to $1.20 per ton.

In this same district at pre-war rates the amount paid for supervision and labor in the operation of the freigth houses amounted to about 50 cents per ton, so that if interest on the value of land were charged directly against freight house operation it would amount to double the total labor charge.

It has been this condition that has caused the advocacy in Chicago of the two-level type of freight house, requiring only half the land.

The single-level type of freight house wits its accompanying tracks can be provided for about $2.00 per square foot, and the double-level type for about $5.00.

With these figures as a basis the relative economy, so far as interest on land used is concerned, is:

	ASSUMED VALUE OF LAND			
Per square foot	$5.00	$10.00	$15.00	$20.00
Interest charge per ton @ 6% single level	$0.42	$0.72	$1.02	$1.32
Interest charge per ton @ 6% double level	0.30	0.45	0.60	0.75
Saving, cents per ton	$0.12	$0.27	$0.42	$0.57

There are possible economies in connection with the operation of multiple-level freight stations which still further favor this type, but these fall under the subject of operation and it is the purpose herein to cover only those economies connected with land usage.

There are examples of multiple-level freight stations in Philadelphia, Pittsburgh, Minneapolis and St. Louis, but in all of these cases the type was adopted primarily on account of topographic conditions and not because of the more economic use of land.

In the west side terminal area in Chicago, while the land area occupied is practically level, the necessity of carrying streets through the area on viaducts to connect with bridges over the Chicago River directed attention to the possibility of economies in multiple-level development.

*Digest of Report by Terminal Committee, W. S. E., before spring meeting A. S. M. E., May 25, 1921.
**Engineer, Chicago Terminal Commission.

The Pennsylvania freight house in this west side area is of the two-level type with storage space above, and has been in operation for several years. A portion of the Alton freight house in the same area, also of the two-level type, has just been completed and put in operation, and there is under construction another portion in which there will be several floors for general office and warehouse purposes. Construction has been started on the Burlington freight house, in the same area, which is also of the two-level type with warehousing space above.

The railroad occupied territory in the west-side area is separated from the central business district by the Chicago River. The river and the railroad occupied property together forming an effective barrier to the extension of the central business district continuously in a western direction, so that this property is naturally segregated with its own disitnctive features and the treatment is more or less specific, and probably not generally applicable to situations in other cities.

The railroad occupied territory south of the central business district of Chicago is in a somewhat different situation. Here there are no natural barriers to the extension of the business district southward, the only barrier bieng the presence of railroad occupation.

The opportunity is therefore presented of developing a treatment of this property in a way that will permit of its most economic use and at the same time remove the barrier to the expansion of the business district.

As has been shown, there is a precedent for the adoption of the two-level type freight stations where land values are sufficiently high. The construction of hotels, apartment houses and other high-grade structures over the property occupied by the tracks of the New York Central Railroad at New York City furnish a precedent for the full use of air rights on valuable real estate occupied by railroads. In the treatment of the railroad occupied territory south of the central business district in Chicago the effort should be made to create a character of improvement that would permit of a commercial development super-imposed on the railroad development and extending to such heights found to be economically correct.

This property is adjacent to the south branch of the river and incidental to the development would be the straightening of this river so that it would be parallel with the general direction of the north and south streets and make possible the opening of additional thoroughfares through the district.

Through the railroad district there could then be constructed streets extending north and south and east and west carried on viaducts on substantially the same level as the floor of the river bridges.

Team traffic to the freight house would use the driveways on the viaduct level located between the north and south streets, and covering the railroad freight houses would be a commercial development which would have frontage on the north and south streets independent of the access to the freight houses.

We would thus have an artificial plateau created in an otherwise level area with a railroad and commercial development—each independent of the other—and having each its own method of access.

In the particular district referred to in Chicago, the area treated would have a width of about a quarter of a mile and a length of about

three quarters of a mile. The space developed over the railroads would be in the form of several units. These units could be interconnected by tunnels so that all warehousing space in the district would have access for inbound and outbound shipments to every track of every railroad having its facilities in this district.

The saving drayage costs alone would be an important item and the removal of this drayage from the city streets would be a very great benefit to the city—particularly as the streets in the downtown district have already reached almost the limit of congestion.

On the basis of present rentals for loft buildings in the same general vicinity, the air right development would yield a net return sufficient to pay interest charges on the construction cost of both the air right and railroad development.

The proposition of more intensive use of valuable real estate held by railroads in large cities is economically sound; will be an important factor in financing improvements in city freight terminals and is demanded from the standpoint of civic betterment.

SOME ASPECTS OF THE PROBLEM OF CHICAGO AS THE MID-INTERIOR RAIL-WATER GATEWAY*

By J. R. Bibbins**

Anyone who attempts to discuss the transportation problem today immediately becomes so immersed in conflicting relationships between the various elements of the transport machine that a discussion is hardly possible without reference to these elements and the relative weight which they possess in the general result.

Under the urge of European demand, the rail trunk system of today is largely concentrated in the latitude north of Chicago-St. Louis and fans out west of these points into a great collecting system of feeders. Over this great transcontinental belt travels most of the interior tonnage and the world's supply of American products.

Notwithstanding the growing importance of the New Orleans-Galveston ports, a relatively minor development has taken place north and south. This tendency toward concentration has developed in intense form the problem of the gateways such as Chicago, St. Louis, Cleveland, Pittsburgh, Buffalo, etc. And it is with this problem that Chicago has mainly to deal. This is not simply a problem of providing continuous rail transit through a congested metropolis but in most of these cases the gateway is a division terminal break-up and transshipment point or terminal transfer point between connecting roads, as well as a large producing district requiring carload service for incoming raw materials and both c. l. and l. c. l. service for outgoing fabricated product.

It is easy to understand why the Chicago gateway has become the mid-continental focus of activity, for the Great Lakes themselves have molded the transportation plan of the whole country. There was a time when Chicago's shipping held the distinction of being greater in tonnage than that of Liverpool and London combined, and it is a fact that about 1917 the gross tonnage of the Great Lakes fleet was actually greater than the tonnage over the entire merchant marine under American registry

**Consulting Engineer, Chicago.
*Digest of Report by Terminal Committee, W. S. E., before spring meeting A. S. M. E., May 25, 1921.

(i. e. vessels over 1,000 tons). True, most of this was bulky, low grade tonnage but the fact remains that the Great Lakes do form a vastly important arm of the transport service.

Thus we are warranted in examining the port of Chicago for this great gateway hold the potential place of a water-gate as well as a rail head. When the possibilities are developed, Chicago will be the cross-road of the continent in fact as well as in simile, and the problem which engineers must work out in the near future is to design a proper and efficient working machine for handling quickly and cheaply this vast transcontinental tonnage as well as its own originating tonnage. The preponderance of east-west rail movement will no doubt remain, although looking well into the future it seems hardly sensible, on the ground of national safety, that over one-half of the nation's export production should be passed through the "bottle-neck" of New York harbor.

The Chicago Gateway may be expected to function as, (1) the principal east-west divisional transfer point between east and west railroads, (2) the northern rail head of the Mississippi Valley roads, and (3) the watergate for the interior, via the Great Lakes Route. Thus, in some respects, the Chicago port-terminal problem is more complicated than any other port in the country, if not in the world, in its ultimate aspects. For in addition to the production of its own 200 to 300 square miles of area it must receive and trans-ship export and import tonnage and quite possibly a very large coast-wise business, via the Panama Canal, either through the St. Lawrence route or the Mississippi barge route.

Added to this complication is the problem of the railroad passenger stations and long-haul rapid transit. Chicago is the principal passenger transfer point of the country. The individual roads have chosen individual terminal development, to a large extent. However, the policy is gradually shifting toward a unification of terminals or joint operation. But the demands on the main line rails for the fast passenger business, and the insistence of the carriers upon independent rail entrances still further complicates the port as a rail head and water-gate. There are over forty operating railroad companies in the Chicago district and twelve major truck entrances for passenger service. While an attempt has been made by the four concentric belt lines surrounding Chicago to relieve these truck rails of transfer freight movement, the problem of confiict between freight and passenger movement is still the perplexing one.

All of the principal local freight terminals for the Chicago roads are located within the one-mile zone downtown. These stations handle the central retail and wholesale tonnage and also handle the transfer tonnage between the incoming carriers of east, west and south. Thus before the war, over half of the tonnage of the Chicago district was transfer tonnage c. l. and l. c. l., and 60 per cent of the l. c. l. portion was transferred across the city streets of the business district. In spite of this, there exists under the city streets a complete gridiron of freight tunnels 65 miles in total length in which is to be found the most refined system of classification of package freight in the country.

Into this same downtown district pours daily approximately one million people engaged in business, shopping and pleasure, and ultimately trans-lake, coastwise and foreign shipping will bring in additional daily crowds of people to add to the problem.

Thus, Chicago possesses a unique problem within its one-mile zone of business district and its 200 square miles of territory, already with three levels of transportation, passenger elevated above, surface lines and steam on the surface and freight subway beneath the surface, and this in addition to freight transport by water, rail, barge and lighter. In the future, with passenger subways, a fourth transportation level will be added.

With the above brief resume of the physical and economic factors involved in the problem in the Port of Chicago, it is evident that the problem can only be solved by progressive work upon its detailed aspects. The balance of the discussion of the Terminal Committee is therefore devoted to the points selected.

THE RELATION OF STEAM ROADS TO RAPID TRANSIT DEVELOPMENT*

By Lt. Col. Bion J. Arnold**

Urban rapid transit seems to have become, in many cases, a by-product of political expediency, piece-meal development and endless delays. This is not as it should be and in the last analysis plays havoc with normal, healthy, urban development. It is the purpose of this brief statement to present a somewhat new aspect of the old problem with a definite suggestion that the time has come for the steam railroads of the large cities, especially those who are fortunate enough to own entrance rights-of-way strategically situated for long haul suburban traffic to enter the rapid transit field and enter it properly.

The case of Chicago may be analyzed briefly for illustrative purposes. While Chicago is territorially a big city, 200 square miles in area, with commuter suburbs extending 15 to 20 miles in all directions, nevertheless the analysis here will apply equally in principle to a number of other large cities of the United States. In common with other cities, Chicago's business center is highly concentrated within a so-called "loop" (8 x 10 blocks) wherein is conducted the major portion of the wholesale, department store, high class shopping, theatre, restaurant, club, business and centralized social activities of the city. Twenty-six railroad carriers enter this central district over twelve major trunk lines with a traffic of 1,340 trains per day and 195,000 passengers per day. All this business is concentrated in five passenger stations which are clustered around the boundaries of the Loop as close in as the price of property and the competitive condition of property at the time permitted when the stations were originally located.

There is no attempt at co-operation in terminal passenger handling although all leasee roads naturally use the entrance facilities and stations of the lessor roads. While the LaSalle Street Station is a fairly useful modern structure of the arch shed type, there is but one really modern station, the Northwestern station, using the Bush shed. However, the Union Station group, Pennsylvania, St. Paul, Burlington and Alton, have a large double end station under way, and the Illinois Central is planning a very extensive two-level union terminal on the lake-front. Thus ,probably $150,000,000 investment is involved in the newer Chicago passenger structures.

*Digest of Report by Terminal Committee, W. S. E., before spring meeting A. S. M. E., May 25, 1921.
**Consulting Engineer, Chicago.

None of these, with the exception of the Illinois Central development, is especially adopted for economical and quick handling of commuter or rapid transit business. On the other hand they are distinctly ill-adapted for handling the large growth in future traffic which will undoubtedly come. While these stations are distributed around the borders of the most intensively developed part of the business district, there is no inter-communication between them and consequently these terminals must necessarily remain as traffic "dumps" rather than as traffic distributors. Moreover, the appropriation of a large part of these expensive and monumental structures for rapid transit purposes forces in to bold relief the economic impropriety of a terminal system in which terminal charges per passenger, using the facilities, may exceed the entire revenue received from the commuter trip.

The Illinois Central lake-front system alone approaches the ideal of a rapid transit distributing system, with stations *distributed* along the boundaries of the business district instead of concentrated at one point.

The statement is frequently made by railroad executives, and without refutation, and the commuter rapid transit business does not pay or is carried at a large loss which must be made up by the long distance overland passenger and freight business. If this is true, thus railroad managements of the country which are confronted with the problem of adequate revenue, stand in the inconsistent position of harboring a passenger terminal system and conducting a public service at the expense of the stockholders or the other patrons of the system. Either aspect, if true, represents an unstable economic condition which cannot last. And if the commuter traffic is not in fact supporting the full cost of producing this service, there is no better time than the present for the railroads to establish the facts in the case and endeavor to have this traffic handled in a more practicable manner.

However, there are some who believe that railroad accounting has not yet been sufficiently perfected to reveal fully the equitable allotment of terminal and service charges as between long distance and local rapid transit service on the steam railroads. Those who defend the use of the monumental terminals claim that they would be required in any event for cross-country travel and that the rapid transit service can therefore be accommodated at very little cost off hours, as a by-product. But this is hardly the case in a large community such as Chicago for the rapid transit peak practically coincides with the main line peak, especially in the morning when over-night travel reaches the city. Still it is claimed that this commuter travel should not bear the same operating costs and fixed terminal charges per passenger as the overland traffic because the suburbanites use relatively few of the main station facilities. Whether this is true or not, it is believed by many engineers in railroad service and in civil life that some careful and thorough research into the economics of railroad suburban passenger business should be instituted at once, with the specific object of finding out whether the railroads could better handle this suburban rapid transit business or turn it over to some other agency better organized to handle this business.

Today the situation in Chicago is unique in both its tendencies and its possibilities. We are in the throes of a transportation quagmire.

Future developments may soon easily become erratic and load upon the city experimental enterprises which have no foundation in technical experience or sound economic principle. Yet the major development filed in Chicago is still clear and with proper designing and sane, careful organizing, a subway transit system may put under way in Chicago which will establish a world-wide precedent.

The hopeful plan in mind seems to be that the steam railroads, which are so strategically located with respect to long haul, suburban commuter traffic should undertake an immediate reorganization of this great arm of local transportation and coordinate its services with the other surveys of the city in such a way that unified operation of the entire local transportation business may be carried on with the least total expense and maximum usefulness. Local transportation has long ceased to permit of competition as an instrument of regulation, and careful studies of the Chicago situation have shown conclusively the advantages of intimate operating unification. As a result of misrepresentation of facts, the public still opposes this policy and, it is believed, quite unwisely.

But there is a still greater unification possible which forms the burden of this argument. These steam road services are in essential nature a part of the city's rapid transit system. The rights-of-way are located in such strategic positions that it would be quite hopeless to duplicate them through independent rapid transit systems. The capital duplication in semi-competing systems has already gone too far in our cities. It is therefore incumbent upon the railroads to develop their strategic rights-of-way, provide the rapid transit facilities themselves or lease these facilities adjoining their operating tracks or by way of construction so that these immensely valuable traffic ways can be used to greater advantage and profit.

More specifically it is believed that the fuller development of Chicago railroad entrances for long haul rapid transit service should and could be carried out at a fraction of the enormous capital expense of providing a new independent rapid transit system, such as has been proposed from time to time and which would result in a serious extra capital burden upon the city from which it could not escape for decades. Eventually this development of the railroad entrances must come, if any event, as in the case of the New York Grand Central development.

FREIGHT TUNNEL SYSTEM AS A TERMINAL DISTRIBUTION AGENCY*

By J. R. Bibbins and E. J. Noonan

In common with other large centers, Chicago's great need is a terminal delivery agency which will quietly fit into the rail terminal operations and effect the delivery of this tonnage with as little encroachment as possible upon the capacity of streets absolutely required for retail and general business. Outside of motor transport, only three agencies hold possibilities. For lighterage is only available directly to districts adjacent to the river and lake front, and requires trap-car movements to reach inland points. There are:

*Digest of Report by Terminal Committee, W. S. E., before spring meeting A. S. M. E., May 25, 1921.

(*a*) The Chicago Freight Tunnel.
(*b*) River Lighterage.
(*c*) Trap-cars or Ferry Cars.

A freight transport system unique in modern terminal development exists underneath all of the principal downtown streets of Chicago on both sides of the river, which deserves special mention here. This network of tunnels is connected by elevator with all railroad stations, freight houses, important retail, wholesale and mail order houses, warehouses, coal, ash and disposal stations, and in short, with practically all the downtown industries of Chicago. The Tunnel, while small in size, can handle from 70 to 95 per cent of L. C. L. freight tendered in the great majority of cases, and all freight from many of these connections. The Tunnel serves four union L. C. L. stations and a large number of private commercial stations. Some with the shipping floors are at the tunnel level, requiring no tunnel elevators. At these union freight stations, miscellaneous freight for any number of destinations is received from a shipper on a single bill of lading, classified and routed to destination, the Tunnel Company acting as the terminal agent for the carrier road. The freight in these union stations is assembled continuously during the day in small standard cars of about 5.0 tons capacity and is hauled out in trains by electric locomotives and set off on siding at its destination, raised by elevator to the railroad's freight house floor to be loaded out in the day's outbound movement.

Thus the Chicago Tunnel represents the best example today of a high-class terminal freight forwarding machine in which the mechanical sorting of freight is done *entirely* by the carrier to the advantage of the shipper. It may be stated safely that, in ultimate limit of track capacity, the present tunnel could accommodate three ot five times the present tonnage handled and with only moderate improvements in layout and elevator capacity at certain points. At present, the Tunnel is handling approximately 1,800 tons of L. C. L. freight per day, or less than 10 per cent of the total outbound freight at the railroad freight houses. But it could possibly handle 10,000 tons per day. This capacity results from the tunnel layout, which is a single-track gridiron with trains routed in such a way that one street is northbound, the next southbound, etc., with numerous laterals and cross-overs to permit flexibility. These trains average 4.0 miles per hour, 8.0 miles maximum and they are able to traverse the Loop in any direction in the short space of 15 minutes. By systematic dispatching and with block signalling when found necessary, the Chicago Tunnel could function in a manner not generally appreciated at the present time.

To truck 2,000 tons of freight per day would probably require from 750 to 1,000 motor vehicle trips, if fully loaded, each day, or from 90 to 125 round trips per hour in an eight-hour day. Possibly the majority of these vehicles would not average more than three round trips per day, so that to move this tonnage on the street might actually require 250 to 350 vehicles. For 5,000 tons of freight and heavier loadings, 1,500 to 2,000 motor vehicle trips per day might be required, and for 10,000 tons possibly 3,000 trips or more, depending upon the system of motor transport used. Imagine the resulting condition of Loop streets with such traffic.

For the above reasons, the conclusion is reached herein, against much argument to the contrary, that the *Chicago Tunnel must be regarded as an important element in local freight transportation,* and one to be conserved, if for no other reason than to contribute to the relief of street congestion, *for the Tunnel is a sub-level freight handling street already constructed,* and will permit the South Water Street Project to be developed more along the lines of a street improvement than as originally planned with railroad tracks and freight platforms in and along the lower level. The roadways should not be used for this purpose.

Considerable effort was expended in trying to discover why the Chicago Tunnel is not now put to greater use. There are several reasons, none of which would seem to be a reasonable excuse for permitting such a unique transportation agency, involving 65 miles of tunnel line and $15,000,000 of investment, to fall into disuse. These reasons may be summarized as follows:

1. The Tunnel is an independent enterprise with charges absorbed by the carriers; trucking charges are paid by the shipper.
2. Tunnel service appears somewhat more expensive than trucking, although the cost of delayed truck-time may reverse the situation.
3. Apparent greater delays in forwarding due to freight house congestion and hold-overs. Trucked shipments are often favored because of assistance rendered by drivers.
4. Large shippers may change from Tunnel to truck service even for a fractional saving in charges.
5. Some bulky shipments cannot be handled—from 5 or 10 per cent in some cases to 30 per cent in others. The Tunnel averages about 90 per cent availability.
6. Modern tendency to one-way business—for many large merchandisers use carload inbound, L. C. L. outbound via Tunnel. This is no defect of the Tunnel.
7. Duplication of checking work and expense. It should be possible to avoid this in some reasonable manner and would be if the Tunnel were a railroad agency.

A study of the existing Union Tunnel Freight Stations shows the following results as applicable to designing of cacilities recommended herein:

1. Platform space required—25 sq. ft. per ton per ten-hour day.
2. Service track required—One standing car per 10 tons handled per day.
3. Average load per car—1.4 tons general merchandise.
4. Team platform length—0.42 lin. ft. per ton per day.
5. Elevator capacity—30 round trips per hour now; 38 maximum when speeded up.
5. 1,000-ton station requires—25,000 sq. ft. floor space, 420 lin. ft. platform frontage, 1,260 ft. or standing tracks, 2 elevators, 90 merchandise cars.

Union freight station service is believed to be the answer to the charge sometimes made, of discrimination by the Tunnel as between small and large shippers (assuming a classification of freight and

charges levied on a class revenue producing basis rather than a flat tonnage basis.) From the standpoint of the City of Chicago, no transportation agency could be more effective in solving the problem of existing street capacity and no effort should be spared to make this institution one of permanent success.

THE FUNCTION OF THE TERMINAL SURVEY*

By J. R. Bibbins.

Rail terminal movement has usually been regarded as too complex to permit of exact analysis. Within the so-called terminal district of the large cities is found, perhaps, half of the total railroad investment of the country, a large proportion of the rolling stock and the tonnage in transit. Also a very unreasonable part of the time of transit required will be found consumed within terminals, while the cost per ton of both operating and fixed charges mount up to such high figures, as to suggest a most careful inquiry into ways and means of improvement. The very magnitude of these terminal operations seems to justify fully the resort to technical methods to solve problems which have heretofore been considered largely on the basis of precedent and emperical methods.

As a result, a comprehensive view of the origin and destination of all freight movement in a terminal or port has usually been a sealed book, especially in the absence of any centralized authority empowered to secure the necessary information for such a broad conception of operations of individual carriers constituting the terminal system.

Thus the terminal survey has become a new and potent guide to intelligent scientific terminal improvement and for the first time on record the mechanical working of a large metropolitan terminal has been reduced to quantitative as well as qualitative terms by the determination of the origin and destination of all traffic movement. This is believed to be so important that the matter is called to the attention of this transportation session in very brief form.

The complete survey referred to herein covers:

(*a*) The physical plant of the entire terminal district.
(*b*) Its operating plan, capacity and cost.
(*c*) The actual traffic movement through the terminal machine.

In detail the following data was determined:

(1) Origin and destination of all car movements
By wharves—export and import.
By industries—direct delivery or via switching lines.
By carriers' facilities—freight, warehouses and team tracks.
By interchange through and via intermediate lines.
By district carried groups.
(2) Cars held in terminal at various times.
(3) Seasonal variation in all movements.
(4) Movement of empties—logical and illogical.
(5) Point and volume of interchange—useful and excess movements—number of intermediate lines used.
(6) Centers of gravity of tonnage handled with respect to port business, warehouses, local city business, etc.

*Digest of Report by Terminal Committee, W. S. E., before spring meeting A. S. M. E., May 25, 1921.

Briefly the survey indicated:

(1) The relative efficiency of present terminal organization and improvements desirable.

(2) Relative correctness of yard and interchange location and the general lines of future reorganiizng and development—for hump yards, clearing, etc.

(3) Proper development of the City Plan.

(4) Proper location of belt line facilities, so necessary in any port and railroad center.

(5) Desirable form of administration, finance and accounting.

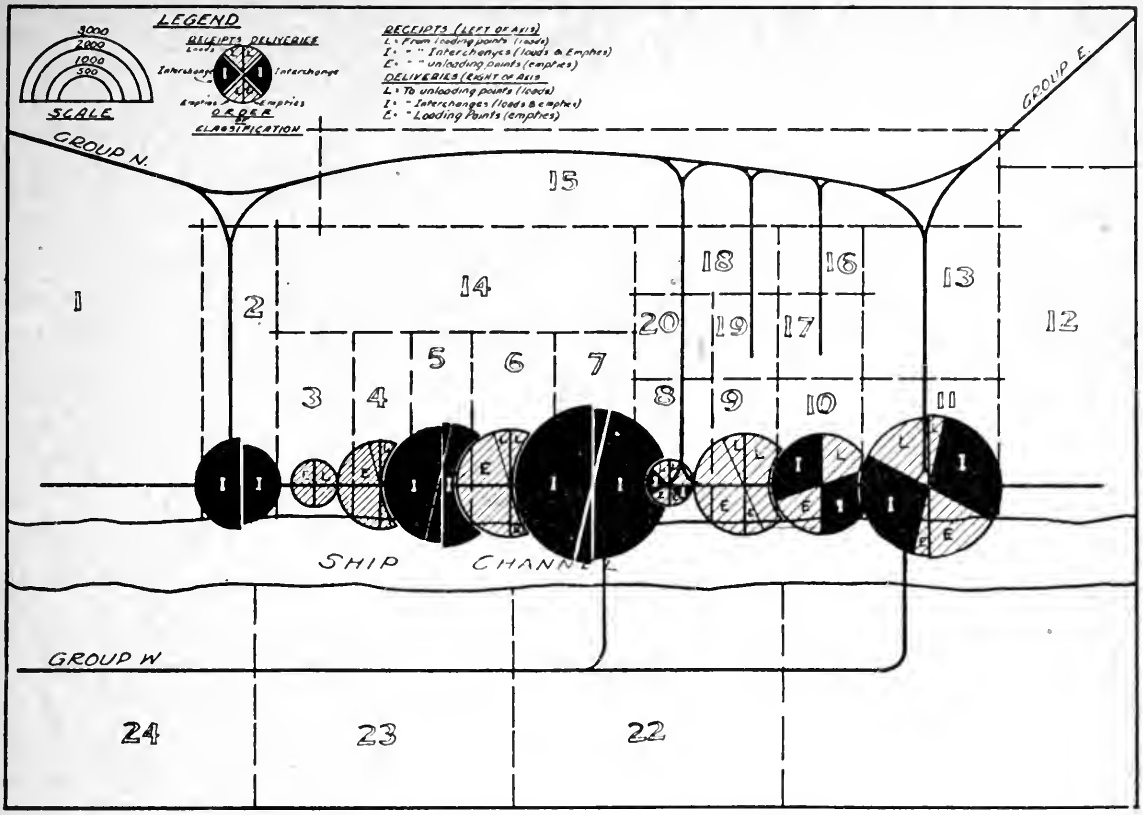
(6) Best methods of coordinating rail-barge and marine operations to the maximum benefit of the city and its tributary commerce.

This economic survey is simply a new method of attacking an old problem and attempts to visualize in concrete form the actual working of a vastly complex terminal plan.

In order that the main conception should not be narrowed by local vision, the survey is here outlined without conference to a particular locality, although actually representing one of the largest terminal problems of the country. The diagrams illustrate in simplified, graphic form what takes place in a composite rail-water terminal. This terminal machine handles approximately 1,000,000 cars per year. Within one or two decades the capacity of the machine must at least double and the problem arises of handling annually 30,000,000 to 40,000,000 tons of freight.

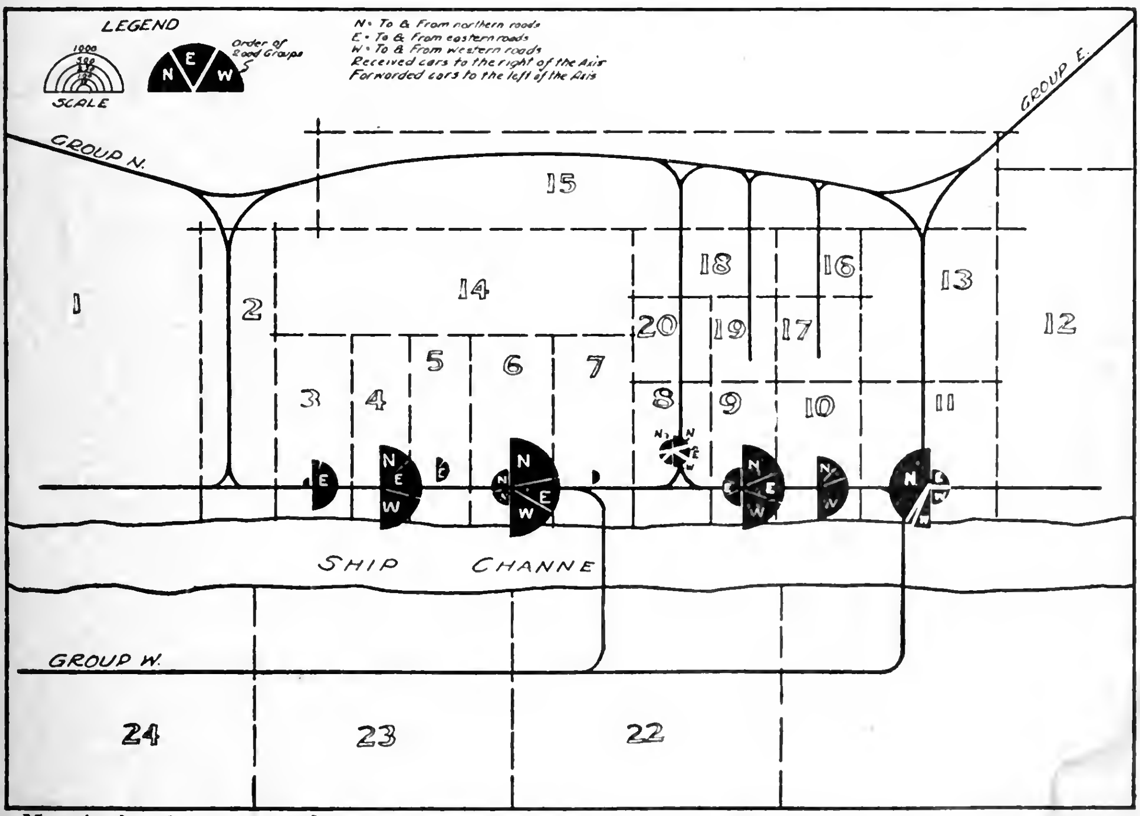
The diagram of total movement in and out indicates an excessive concentration of movement within the most congested district, primarily devoted to marine tonnage. To a considerable extent this is due to the competitive interlocking of individual railroads and terminals, brought about by competitive development. In fact, the struggle for strategic position has been so great in this case that all the terminal tracks, 64 in number of one road, have to be served from one switching lead, and 54 tracks of another terminal road.

The remaining two diagrams compare briefly the actual and useful work done in placing cars by a belt line not properly equipped with terminal and sorting yards and proper interchange points. Thus, four or five times the number of cars were handled on the belt than were required for useful placements and particularly noticeable is the volume of interchange *within* the most congested district instead of outside.



Total car movement handled by a Belt Railroad in the congested water-front district of a large port terminal, including interchange movements which might be handled in less congested districts.

This total work done by the Belt Line in the congested area may be contrasted with the useful work shown in the accompanying diagram.



Magnitude of car movement, handled by a Belt Railroad in the congested water-front district of a large port terminal, originating in or consigned to the water-front district.

This illustrates the relative magnitude of useful work done by the Belt Line in the congested section.

FREIGHT MOVEMENT BY MOTOR TRUCKS VIEW POINT OF CARRIER AND PUBLIC*

By Hugh E. Young**

The claim for superiority of motor truck transportation as compared with rail shipment is based on the following advantages of the former.

The amount of lumber used for packing is less; the amount of material in transit which is not producing revenue either to shipper or receiver while it is in the hands of the carriers is less; and the amount of space used in the shipping department in order to prepare shipments to move via freight is less.

These advantages are more apparent than real, for the reason that with the proper terminal equipment, and by the adoption of methods of handling freight in containers on freight cars, they will be practically eliminated. Local cars handling demountable containers could quickly load and unload at terminals.

In this connection it should be understood that speed in loading the individual car will not be productive of the required results if that car is held up in a train of cars which does not move. This points a way to the real solution, the answer to which is the development of terminal buildings and equipment so arranged to load an entire train of cars at one time by having several container loading devices serving simultaneously.

In Chicago, interchange between a number of freight terminals is made by truck transport through the heart of the business district. The development of Marginal Ways, such as the new South Water Street Improvement and the proposed Market Street Improvement, will cause a part of this traffic to be re-routed to lower level thoroughfares independent of cross street traffic and fast moving traffic.

The present inadequate freight stations and the lack of terminal equipment make local car movement between certain terminals impracticable. At the present time, in Chicago, we have interchange and transport from main to local station partly by local car movement, partly by motor truck and team transfer, and partly by the Illinois Tunnel Company's service. The Illinois Tunnel Company can be expanded to the point of practically eliminating trucking through the loop or downtown district, and local car movement can be made efficient by the employment of modern terminal equipment and methods of handling. It is entirely possible that an Inner Belt Railway may be developed for L. C. L. interchange. This appears to be the logical method for freight interchange and by the scientific development of a distribution system it will be possible to ship from the origin in demountable containers so that L. C. L. interchange becomes a container interchange.

MOTOR TRUCKS FOR L. C. L. INTERCHANGE.

Long distance motor transport obviously cannot and should not compete with rail transport. The through freight calls for expensive terminals, the maintenance of which contribtues largely to the freight rate. These terminals must be served by either motor trucks for interchange of freight, or by trap car service.

*Digest of Report by Terminal Committee, W. S. E., before spring meeting A. S. M. E., May 25, 1921.
**Engineer, Chicago Plan Commission.

Before the motor truck replaces trap car service in order to relieve the rail terminals of local car movement congestion, investigation should be made to determine if a scientific handling of freight by modern terminal equipment and the employment of such schemes as adopted in Cincinnati, where package freight is loaded into demountable containers, or truck bodies, which are transported to and from motor chassis mechanically, can accomplish the same results. *The principal factor contributing to* the local car congestion is a *lack of modern terminal equipment.*

In reports from Cincinnati much has been said of the advantages of motor trucks for interchange between terminals and transport between main station and sub-station, but the effect of such traffic on the maintenance of highways, and the loss to the public due to street traffic congection, are not considered in the accounting.

The tendency in the trucking business towards handling a large freight transfer tonnage wholesale by contract, has developed within late years. Quite recently a new plan has appeared using standard two to five ton motor trucks built with *interchangeable bodies* so that the more expensive chassis may be kept in continuous operation. Thus *house or shippers'* freight can be loaded and unloaded in these unit containers as required, independent of the truck itself or its time or arrival and departure. It is even proposed by advocates of this system that motor trucks should replace trap car service as now operated, thus relieving the rail terminals of much local movement.

This contract motor transport plan has advantages, some very real and some apparent. It aims to reduce street congestion by concentrating bulk, and, by maximum loading, reduce the number of motor trucks on the public streets required for freight service. It provides greater latitude in timing of various transport movements so that individual shipments can be handled with greater ease and less confusion at the freight houses.

However, for the Chicago situation, the fact should not be lost sight of that any plan of motor transport, whether individual or by contract, is defective if the *downtown public streets are used as a right-of-way* for a class of traffic which is primarily rail tonnage and should be considered as such. Loop streets are now all too few and narrow, without deliberately planning for their further use for transporting railroad tonnage.

The motor trucks are our immediate concern, as this transport system is so flexible that it may be quickly expanded to an embarrassing extent. It is also easily re-routed, and it is in this possibility of routing motor traffic *around* the loop by a Marginal Way, that Chicago's South Water Street Improvement and its extension southward holds such promise.

About 6,000 tons are daily transferred by car, tunnel and teams. 1,740 tons are hauled from inbound houses to the connecting road's outbound houses. Eighteen per cent thereof, or 317 tons, is interchangeable with the Illinois Central and Michigan Central Railroads. The location of many of these freight houses at the present time is such that the direction of travel is across the Loop streets.

With the lower level South Water Street as a distributor, it can be safely asserted that all freight interchange between groups on the west

and south sides and the Michigan Central and Illinois Central stations on the east side, will certainly use the lower level of South Water Street and thus remove daily 200 teams from the central Loop district, hauling two tons each. This, added to the 1,700 daily team trips to the Illinois Central outbound freight house that will be diverted to the lower level of South Water Street, makes a total of 1,900 daily team trips taken from the Loop streets.

The field of the motor truck, eliminating the wasteful competition with rail carriers, is almost unlimited.

The importance of legitimate highway transportation has been overlooked in a remarkable manner when it is considered that all movement of produce in the course of its production from raw material to finished product, starts on the highways and finishes over the highways. As a method of transportation incident to railroad transportation and as a solution of the short haul problem, it far outranks in importance all other means of transportation.

PROBLEM OF PROVIDING RIGHT-OF-WAY AND SUITABLE PAVEMENTS FOR MOTOR TRUCK MOVEMENT AND VIEWPOINT OF PUBLIC AND CARRIER.

Public authorities are rapidly awakening to the fact that the public highways are being destroyed by motor trucks handling tonnage which should be handled by railroad. The following is typical of the viewpoint of the motor carrier, and it is to be noted that here again the economic waste of duplicating rail service with motor service, the cost of construction and maintenance of highways, and traffic congestion with resultant loss and inconvenience to the public, are lost sight of and evidence is shown of lack of a proper understanding of the important relation of the railroad to the prosperity of the country.

This opinion says that the motor truck in the field of short haul and transportation is the last word in efficiency; that the present highway construction will not carry the vehicle which is operating over it; that the public has jumped to the conclusion that the cost of the construction of highways is due to their use by heavy duty vehicles, whereas investigations have clearly demonstrated that our highways are going to pieces simply because they are constructed without reference to the bearing capacity of sub-soil, drainage or the construction of the proper foundations; that if legislatures have determined that the heavy truck is the cause of breaking up roads, it is self-evident that they are going to legislate against the use of that truck; that if they have an elementary knowledge of the importance of transportation they will attempt to shape constructive legislation for the improvement of the highways.

The motor truck owners are of the opinion that the highway is of such material benefit to the general public that the cost of construction of the highway should be borne by the public through general taxation. Motor truck opinion is in favor of the Townsend bill which provides for a system of Federal highways constructed and maintained by the Federal Government.

FUNDAMENTALS IN THE MOTOR AND RAIL TRANSPORT MATTERS AND REASONS WHY THE PREVAILING MISAPPREHENSION SHOULD BE CORRECTED BEFORE IT IS TOO LATE.

1. It is an economic waste to duplicate rail freighting with motor

truck freighting in a territory that can be amply served by the rail carrier, for the reason that the motor truck can never displace the rail carrier for long haul and cannot handle C. L. freight business as efficiently. Recognizing the necessity of the rail carrier; realizing that the prosperity of the country depends on railroad transportation, considering the present difficulties of railroad financing, and knowing the economic waste in duplicating transportation systems for the same business, it is absurd to assume that in the final accounting there is a saving to the consumer in motor truck delivery. Neglecting the cost of construction and maintenance of highways, which cost more per mile than railroads, and even if commodities were delivered free of charge by the motor truck, the public must still pay a return in some manner or other on the rail investment if it expects to have such utility maintained and operated otherwise it will be a case of dismantling the railroad. This latter procedure is already being threatened by one railroad.

2. The use of the motor truck for interchange between terminals and transport between main and sub-station before being accepted on its face value, should be investigated as to its economy, taking into consideration the cost of maintenance of highways over which it operates, and any plan of motor transport, whether individual or by contract, is deficient if downtown public streets are used as a right-of-way for a class of traffic which is primarily rail tonnage.

3. Motor truck transport is subject to the same laws of economics, and should be subjected to the same system of accounting as railroads and other utilities. The heavy duty motor truck transport as a method of transportation incident to railroad transportation and as a solution of the short haul problem should be limited to specially constructed highways, and as users of these highways should be taxed in proportion to their use of it, in order to maintain that highway in a condition which will carry the traffic which goes over it. When the life of a highway is determined by motor truck usage, it is far more equitable to tax the motor transport for it, thereby directing the cost through the proper channels to the ultimate consumer, than to cover the cost by general taxation, for it can be easily seen that such transport might only benefit a part of the territory assessed by a general tax.

FUTURE DEVELOPMENT.

A further development in motor truck transportation and in the use of the unit container body for freight shipment from store-door to store-door is suggested by the following. While this system in some respects is impractical now, certain parts of it are already in operation, and this suggestion may be of some value in the future development of this industry towards the end that the public shall be benefited by the transportation system that is most economical in operation and that will free city streets as far as possible from traffic congestion.

OUTBOUND FREIGHT.

Local collecting or pick-up stations to be established throughout the city for door delivery, these collecting stations to be zoned with respect to streets over which delivery is to be made to the railway terminals, the

object being to eliminate the present unscientific method of carting L. C. L. packages in small quantities to and from terminals. Industries doing a large shipping business to have their own stations.

The L. C. L. freight to be placed in unit containers or demountable truck bodies at collecting station and loaded mechanically onto motor chassis for delivery to railroad terminal. For containers with complete shipments, it will be a matter of door-to-door shipment.

New rail terminals to be built and equipped with modern mechanical apparatus for handling unit containers; buildings to be so constructed that by developing "the air rights" ample floor space can be obtained for sorting of freight. When the trucks arrive at the terminal the store-door delivery containers can be taken directly to the special team tracks and there lifted mechanically onto container cars; the containers having L. C. L. freight requiring sorting for destination to be unloaded on a terminal floor, sorted, placed in containers and loaded onto cars, by mechanical means. This will eliminate needless handling of goods at the terminals.

The terminal building becomes a factory, the business of which is to sort and place freight in containers by mechanical means, obviously a comparatively simple operation requiring less skilled class of labor than necessary in the average factory. The various floors of the terminal building can become separate units fitted with a complete compliment of destination containers and so arranged that space back of containers can be conserved as warehouse storage for each corresponding destination. If necessary each complete unit of terminal floor can be placed on a time scehdule with reference to receipt of freight so that clearings can be made to suit requirements.

The advantages of tihs system can be readily seen when compared with the present system of spotting cars at the rail terminals and trucking L. C. L. freight from car to car, resulting in a stagnation of cars in the terminal. The container cars can be backed into the terminal station and loaded in a comparatively short time with containers and then taken out to main line for distribution.

INBOUND FREIGHT.

Freight arriving in carload lots from outer belt clearing to be delivered at an inner belt unit container interchange yard, these yards to be located on the outskirts of the city and mechanically equipped so that unit containers can be quickly interchanged in cars for proper road destination, this inner belt interchange system to perform the same function by rail that is now performer in Cincinnati my motor truck transport through the city, thereby removing practically 70 per cent of the trucking across streets. The containers are then advanced to the city terminal where transport from main to local station can be accomplished by motor chassis. Freight that is billed for door delivery direct can be loaded onto motor chassis while other freight, after assortment has been made on city terminal floor, can be placed in containers for local stations and delivered by motor chassis.

The above very general description of a cycle of freight shipment covers both the case of door-to-door shipment and the class of freight requiring sorting at terminal. The door-to-door delivery system is now

in operation between Chicago and Cleveland, as already described, and the unit container interchange is in operation in Cincinnati by means of trucking through the streets, which operation in this scheme is accomplished at belt interchange yard reducing the truck traansport to deliveries from main to local station and door delivery. The above system eliminates all trucking from flat cars to terminal platforms. The container cars can move quickly in and out of terminals and the great saving in time and cost can be appreciated when the present conditions of terminals is considered. Today we have a most inadequate system of handling both in and outbound freight, resulting in stagnation of cars and heavy loss in time and money.

The system will require a new method of accounting in regard to the handling of unit containers between roads, and containers will have to be marked with ownership and routed so as to facilitate interchange at clearing yards.

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TECHNICAL PAPERS

ELECTRIC PROPULSION FOR THE MERCHANT MARINE

By Wilfred Sykes*

Presented March 28· 1921.

At about the same time the geared turbine was first receiving attention in marine work, the Diesel engine, which has been previously built in relatively small sizes for land service, began to attract the attention of marine engineers. The unodubted economy of the internal combustion engine was, of course, very desirable but it took many years to develop successful designs, especially for the larger capacities. As is well known, the difficulty of building any internal combustion engine increases with the dimensions of the cylinders. It might be mentioned that as the size of cylinders increases, the weight per horse-power of the engine increases, contrary to the usual experience, as for instance with turbines where the weight of horse-power decreases with the increase in capacity. To my mind this is an indication that we are on the wrong track with the internal combustion engine, as we are trying to force an unnatural line of development.

The Diesel engine was developed by foreign builders until it reached a state of attracting the attention of shipbuilders. At the present time a considerable number of important ships are in service or are being built with internal combustion engines. From the variety of designs, it is evident that we have not yet reached any settled line of development. The great disadvantage of the Diesel engine has been its high cost and also the necessity of skillful operation to insure reliability. Again we have to face the human factor as there have not been good men available to handle such engines and unless skillfully cared for, the results are unsatisfactory. This is mainly due to a lack of understanding of the fundamentals of such machines. These difficulties increase as the size of the unit is increased.

Most of the successful engines work on the four cycle system, although there are one or two prominent makers building engines of two cycle size. The four cycle engine shows the best economy of any to date. In the original Diesel engine, fuel was injected into the cylinder with air at a high pressure. There is a tendency at the present time to eliminate the air comprssors which have always been troublesome and to use a so-called "solid injection" which simply means that the oil is mechanically sprayed into the cylinder under very high pressure, running three

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thousand to five thousand pounds to the square inch. All that is necessary is to bring the oil into intimate contact with the air in the cylinder, for which purpose it is necessary to finely sub-divide it and give it such mechanical motion as to insure proper distribution.

Of great importance has been the recent development, in the case of the Diesel engines, of a new type of which two designs are in operation, the Fullagar and the Doxford. Both of these engines differ from the conventional design in that they have two opposed pistons in each cylinder, the upper piston being connected to the crank by suitable rods. The cylinder, therefore, is simply an open barrel and it is evident that with an engine of this type, the weight can be materially reduced and due to the opposed piston idea, more work can be gotten out of a certain diameter cylinder than is possible with the conventional design. For instance, in the case of an engine recently built by the Doxford people with a cylinder diameter of about 22 inches, the output was 650 H. P. per cylinder at 77 revolutions. With the ordinary design, a cylinder of this size would develop about 180 H. P. It is obvious that the mechanical stresses with a machine of this kind make it possible to use lighter framing so that with a development of this idea, it is possible that Diesel engines for direct connecting to propellers, will receive a great impetus.

In general, direct connected Diesel engines will not require more than about 40 per cent of the fuel necessary for an oil-burining boat with geared turbines. The cost, however, of Diesel drive is usually from 30 to 40 per cent more than that of the geared turbine with boilers and auxiliaries. As far as the United States is concerned, little progress has been made towards building large engines of this type. Several of the manufacturers have taken licenses from foreign builders to use their patents but so far engines have not been built in this country comparable in size with those abroad and in fact the only Diesel engines built for marine purposes have been of a few hundred horse-power per unit. In this respect, the United States has very greatly lagged behind Europe. There is probably more activity in the Diesel engine field in England than in all the rest of the world put together, as the English are very alive to the importance of economy in operation.

So far I have not mentioned the subject of electric propulsion for merchant marine which was the advertised subject of this talk. Electric propulsion has been talked about for a long time and received its first trial when it was adopted for the U. S. S. Jupiter. This was an installation of about 5,500 H. P. and after seven or eight years' operation has been shown to be reliable and satisfactory installation. After the success of the Jupiter electric drive was adopted for the battleship New Mexico and the success of this installation has been undoubted. There were naturally a few minor points requiring attention and changes, but they were insignificant, and the installation was a real success. After arriving at the decision to install electric drive on the U. S. S. New Mexico, the Navy Department decided that due to the possibility of building better ships with electric drive, than was possible with any other system, to adopt this system for the whole program of capital ships then being designed.

The use of electricity will allow machinery to be disposed in such a manner as to give much greater protection in case of under water attack, than is possible with other types of propulsion, so that the newer ships from the Tennessee on, to a great extent, can ignore torpedo attack. This is primarily the reason for the adoption of electricity for battleships. There are some secondary advantages, such as economy, which is very good, especially for light loads, ease of manipulation and great maneuvering power. With the electric drive we avoid the necessity of reversing turbines

which overcomes one of the disadvantages of straight turbine drive. The facility with which the generating equipment can be distributed makes possible very simple arrangements of engines and boilers. There were no particular problems to be overcome in this type of electric drive as we were simply taking the units that had already been tried out in central stations and industrial plants and with suitable modifications, putting them on ship and the operation of the units to date has shown that there are no special characteristics required for shipboard equipment. Of course, reduction of weight is alawys desirable and in the case of fighting ships, every ton that can be saved makes possible the carrying of so much more armor or guns.

The use of electric drive in battleships has, I believe, marked a step in advance in propelling machinery for such service. However, as anyone familiar with marine practice knows, naval vessels have very special conditions under which they operate and the experience gained cannot be directly applied to the merchant marine. In the case of merchant marine, installations have been made with turbo generators which supply power to the motors connected to the propellors. Here the electric drive, while introducing more units, avoids some disadvantages of the geared turbine. For instance, we have no reversing turbine.

We can locate propelling motors aft in the ship independently of the location of the boilers and generators, thereby avoiding shaft alleys and long shafting and giving a better distribution of cargo space. On the other hand, we sacrifice a little in economy, probably 5 to 6 per cent, and we increase the weight compared with geared turbine somewhat, but this is not very important. We make it possible to use higher superheats safely and no doubt the electric will be quite as reliable as the geared turbine, providing the designers do not fall into the same error as did the designers of the geared turbine and attempt to make their equipments too light, either for the purpose of saving weight or to save a little in first cost.

In navy work, a battleship runs probably 95 per cent of the time at one-half power or less whereas in merchant marine, a ship runs only at reduced power when entering port under adverse weather conditions, and it will be readily appreciated that these two different requirements materially effect the lay-out of the equipments used. It makes the problem of the merchant marine simpler than that of the navy so that the equipments used consist of an ordinary induction or synchronous motor and an ordinary generator. I am of the opinion that equipments requiring special automatic control to insure proper operation will be found not advantageous for marine purposes but that eventually, if electric drive becomes a factor, it will be worked out with the simplest type of generators, motors and control equipment, possibly some form of squirrel cage motor with practically no control equipment will be a good type. As stated above, the electric drive with turbines as a prime mover, is at a slight disadvantage compared with the geared turbine and I am of the opinion that if the geared turbine shows that it is a thoroughly dependable machine, the future of electric drive of this type will be decidedly limited.

There is one type of electric for which I think there is considerable future and which has been experimented with to some extent in the last few years. That is a combination of Diesel engines and electric drive. As pointed out previously, the difficulties of building Diesel engines increased very greatly with cylinder dimensions. The idea was developed of using relatively small high speed Diesel engines driving generators which in turn would drive a motor or motors connected to the propellor. The efficiency of engines developing say 75 H. P. per cylinder is practically the same as engines of the largest capacity so that there will be no loss in

this respect. On the other hand, there would be the loss of electric transmission amounting to say about 12 per cent but this would be partially overcome by the fact that slow speed propellors could be used running, in the case of a tramp steamer, at say 80 or 90 revolutions compared with a speed of say 120 revolutions customary with direct connected Diesel engines.

The problem of running a number of Diesel engines together is difficult from the standpoint of alternating current transmission. However, if we use direct current, it is simplified. Generators can run in series feeding into one motor or they can be grouped, series and parallel, and by proper regulation can be easily balanced up so that slight variations in speed of the engines, do not affect us. With a scheme of this kind, we have the greatest possible flexibility. For instance, take the case of four engines and one motor, if we use 150 volt generators we will get 600 volts on the propelling motor, which can be safely used under conditions at sea. Of course, higher voltage could be used although I believe it wise to be conservative in this sespect in the beginning. The failure of one generator or one engine would simply mean that it would be cut out of service and the voltage would be correspondingly reduced and by properly manipulating the field of the motor, the proper speed could be obtained to use the three-quarter capacity available.

To obtain an intermediate speed for maneuvering, it is only necessary to regulate the field of the generators. With a scheme of this kind we can do something which has not heretofore been done with Diesel engines. As a moderate sized cylinder is used, the engine can be simplified as piston cooling can be avoided. Engines of four, six or eight cylinders, could be built up and I believe the whole range of requirements say from the smallest to installations of 5,000 to 6,000 H. P. could be covered using one size of cylinder with one size valve, etc. On such a basis, engines could be built on a truly manufacturing scale which would do more toward bringing down the cost than any other single factor.

Due to the varied requirements of different ships, Diesel engines have been built rather than manufactured with the accompanying higher costs. I have no doubt that such a scheme can be worked out so as to be comparable in price and weight with the geared turbine and with a fuel consumption of not over about 50 per cent of that of the geared turbine installation.

In the above I have just briefly sketched the different schemes of propulsion. Taking the reciprocating engine as a basis, the fuel requirements can be summarized about as follows:

Reciprocating engines—100 per cent.

Geared turbines—about 70 per cent.

Electric drive for steam turbines—about 75 per cent.

Direct connected Diesel engines—about 33 to 35 per cent.

Diesel electric drive—about 37 to 40 per cent.

At the signing of the armistice, the United States aws in an enviable position from the standpoint of shipping tonnage completed and under construction, compared with the position that existed before the war. There can be no doubt of the desirability of carrying our foreign trade in our own ships and from 1915 on, great progress was made, which was accelerated when the United States went into the war, when one of the most important factors was the demand for shipping capacity. The United States jumped from having a tonnage of about 4,000,000 to having in commission and under construction about 12,000,000 tons in a period of three or

four years. It would seem that this was a big step forward and would put the United States in a more favorable position in the shipping world in relation to other countries than ever existed before.

This condition, however, is more apparent than real as the possession of ships does not make us a shipping nation anymore than would the possession of large areas of unused land make us an agricultural nation. The mere possession of a large tonnage of ships, when not employed, is not only useless to a country but is a severe economic drain on its resources, to which every one of us in some form or the other must contribute. At the present time the ship-building industry has dropped to a low level and millions of tons of shipping are tied up in the harbors.

At the signing of the armistice, the chief shipping nation of the world, England had had its tonnage very greatly reduced by the depredations of German submarines. There had been a net decline of about 25 per cent of its tonnage compared with the pre-war figure. The tonnage under construction was about one-third of that under construction in the United States, due to the tremendous demand that the war had made on labor and materials for other purposes which made it impossible for them to in any way keep up with the destruction of tonnage. In the two years that have passed since the armistice, England has again reached its pre-war tonnage and at the end of 1920 had under construction more tonnage than all the rest of the world put together. This was in spite of considerably higher prices for materials and labor charges closely approximating those existing in the United States today. While I do not have any definite figures as to the utilization of existing tonnage, such information as I have indicates that the percentage of idle British tonnage is very much less than than of idle American tonnage.

It is obvious that there must be good reason for these conditions. Dealing first with the construction of ships, the American tonnage is burdened with a tremendous overhead due to the enormously high cost of ship building in this country, especially during the war period. With the exception of a few of the older well-established yards, the people that went into the ship building business knew very little about it and the fault, I believe, primarily existed in the organization of the government.

It would seem natural that if we desired to grow, say, wheat, would employ a farmer that knew something about wheat growing, or if we wanted to build, say, a house, we would employ a bricklayer to lay the bricks, a carpenter to handle the mill work and a plumber to handle the plumbing. These things seem perfectly obvious yet that is just what we *did not* do when we undertook the building of ships which is directly attributable to the well-intentioned but misdirected efforts of the government. Not only was the ship-building program greatly delayed, the cost increased beyond all reason, but the efforts of the country were dissipated, as little was added to the effective weapons for combating the enemy. Of course, the same applies to our aeroplane program and to our ordnance program. However, the war materials, such as aeroplanes, guns, etc., are not with us but have passed into history, but on the other hand we have a large tonnage of shipping and it is obviously our duty to attempt to utilize it in the best possible manner. Much of this tonnage could perhaps best be scrapped. This is certainly the case with the ridiculous program of wooden ships for which so much money and energy was expended contrary to the advice of experienced ship builders. They are rotting by the hundreds as no use has been found for them. In the case of our steel ships the advice of the only people competent to advise was ignored. We built such outrages as Hog Island, etc., where ships could not be built either expeditiously or cheaply and

worst of all tried to run them without the aid of people who knew anything about the game.

The consequence is that we have a couple of billion dollars in shipping tonnage of which a good many hundred millions should be written off as scrap and forgotten and the remainder should probably be written down to about 25 per cent of what it cost, and until this is done, whoever attempts to operate our ships will be carrying a capital burden which will make it impossible to compete with other countries. In business as in nature, 'tis the fittest, that survive and unless we can prove out fitness in the shipping business it will only be a few years before we are hopelessly out of the running. Unless we can build ships at a figure comeptitive with the rest of the world, I don't believe that we have any right to bewail the decline of our shipping. This country with natural resources far superior to any other country and with ample resources of labor, and ability to direct labor, as shown in other industries, should be able to compete with England, which has again captured premier position.

We will never build ships economically with the hot air methods given so much prominence during the war and immediately afterwards but only by hard work and a thorough study of the business. To get on a sound basis we undoubtedly will have to train a portion of our labor in the art of ship building, and in that respect we lag behind Great Britain, which for centuries has had a race of ship builders, the trade passing from father to son with a gradual improvement in ability to perform the duties required from each and every one, from the head of the concern, to the boy heating the rivets. I am, therefore, of the opinion that ship building will be in a precarious position in the United States compared with the rest of the world, until we build on a sound foundation. The older established yards have this foundation to work on but the war yards, in my opinion, will disappear entirely.

To *operate* in competition with the rest of the world we must change our tactics very greatly. The shipping world suffers from the incompetent regulatory practices of the government exactly in the same way as the railroads do today, with a trenmedous waste due to non-sensical regulations governing the size of crews, their rates of pay and the conditions under which they work. It costs between two and three times as much to operate an American ship as it does a British ship. Again it is a case of people not knowing anything about the business taking it out of the control of men who did know. If it costs twice as much to ship materials in an American ship as it does in a British ship and no matter what the freight rates may be, that cost must be paid in some way or the other either directly in increased rates or indirectly through taxes, then it is unreasonable to expect that people will use American ships. During the war, of course, any price would be paid, but now that charters have dropped from between $6.00 and $7.00 a ton per month to less than $2.00, the American ship owner burdened first of all, with an excessive capital charge and then with higher cost of operation, has an almost impossible problem to solve. Located here in Chicago, 1,000 miles from seaboard, comparatively few people appreciate these conditions, but if American shipping is to do anything more than take care of the coastal trade and a few routes very favorably situated, we must first learn how to build ships economically and then be freed from pernicious laws and regulations written by demagogic politicians controlled by short-sighted labor leaders, who are pursuing the same policy as the man who had the goose that laid the golden egg. The efforts of the labor leaders to regulate all working conditions brings with it a deadening of initiation which is disastrous.

I do not intend to discuss in any great detail the technical features of ships but would talk briefly upon some of the engineering features with which we as engineers have more or less interest. Without going back into ancient history of ship propulsion, I will mention a few of the characteristics of propelling machinery as in use today. The great majority of ships are propelled by reciprocating engines, most ocean-going ships having triple expansion. With all the disadvantages of such machinery, it is very reliable although perhaps the least economical in operation. Its reliability, I do not believe to be inherent, but is rather due to the race of sea-going engineers who have been brought up with it and thoroughly understood its operation and know how to prevent troubles or to take care of them when they occur. The long accumulated experience has educated the engineers to such an extent with this class of machinery that its operation can be relied upon and it is this education on the part of the operators that, in my opinion, has more to do with the reliable performance of reciprocating engines than any characteristics of the machines themselves, although they have been very highly developed.

Of course, the difficulties of building reciprocating engines increase as the size is increased so that independent of any question of economy, efforts were made to use a simpler machine for the ships requiring large powers and this led to the employment of the direct connected steam turbine. The reciprocating engine lends itself admirably to the direct connection to the propellor whereas in the case of the direct connected turbine, the designers were faced with the difficult problem of making a compromise of a low speed desired for the propeller and the high speed for economical operation of turbine.

In large ships such as the Mauritania the results obtained were about comparable to what had been attained on ships with large reciprocating engines but on the other hand, the maintenance was reduced and it was also possible to build the units in powers which were hardly conceivable with reciprocating engines. However, such large direct connected turbines are not free from difficulties as has been evidenced by the experience gained on large merchant ships and battleships.

The desirability of close clearances of the blade tips, to avoid undue losses, had to be balanced against the dangers due to distortion caused by unequal expansion of parts, and this is not a linier function but varies roughly with the cube of the power. Furthermore, the turbine suffers from the disadvantage that it is not reversable so that separate reversing units had to be installed. These units normally run under vacuum so as to reduce their losses and consequently are normally relatively cold. When it is necessary to reverse ship no time is available for any preliminary heating up of the reversing turbine, so that the units must go from a cold condition to developing full power as quickly as the valves can be opened. This has been a source of considerable difficulty.

Furthermore, due to limitations of weight, space and cost, the reversing units are usually simplified compared with ahead units with a consequent increase in steam consumption and as the amount of steam is limited, there is usually less power available for reversing than for going ahead. This is not necessarily of great importance in the case of merchant vessels, but is a factor in the case of war vessels where rapid maneuvering is essential. We see, therefore, that although the main propelling units in the case of turbines are simpler than reciprocating engines, we have been forced to add reversing units which operate under favorable conditions and with the considerable increase of complication of piping, valves, etc., which is not necessary with reciprocating engines where the links are simply thrown from one position to another to cause the engine to reverse.

Furthermore, the maneuvering capacity is reduced when turbines are used. As an illustration of this it might be mentioned that the time required to stop the U. S. S. Delaware from 21 knots to dead in the water with reciprocating engines, is about 1¾ minutes. In the case of the U. S. S. Utah, a very similar vessel, but with direct connected turbine, the time to stop was about 5 minutes.

It has long been recognized that the turbine was essentially a high speed machine and that the propeller of a ship gave best results when rotating at a comparatively slow speed; for instance, in the case of a 10 knot tramp, the speed of about 75 to 80 revolutions is the most desirable. This speed is increased with high speed passenger boats to about 100 to 140 revolutions. When dealing with units of two or three thousand horse-power, the desirable turbine speed is in the neighborhood of 3,000 to 3,500 revolutions per minute.

Practically simultaneously Mr. Chas. Parsons and Mr. George Westinghouse developed the idea of gearing between the turbines and propellers. It was a great step in advance from gearing as it existed at that time, as the speeds involved were about twice as high as had been used in any units approaching those in question and the powers to be transmitted were in excess of what had been considered ordinary practice. The war brought about the great developmnt of the geared turbine as the turbine and gears were comparatively small units that could be built quicker than reciprocating engines and involved considerably less material. Of course, under the stress of war conditions and the sudden interference of the slow natural growth of such development, it was to be anticipated that considerable difficulties would be encountered. Now that one has an opportunity of comparing experience, it can be readily seen that the difficulties encountered were not fundamental but were rather due to unknown factors which had to be developed. Unfortunately, once an error was made it was usually multiplied many times, before the first equipment got into service, whereas if the geared turbine had developed naturally, the trouble occurring on one ship would have been corrected before another equipment was built. In general the troubles that have occurred with geared turbine can be classified under about these headings:

1—*Inaccuracy in gear cutting.*
2—*Lack of rigidity.*
3—*Excessive stresses.*

Comparatively little trouble has occurred with the turbines so long as well-established land practice has been followed. Of course, in some cases, there has been a tendency to achieve excessive lightness and this has led to trouble. There has been trouble with gearing due to inaccuracy, although such gears are usually cut more accurately than commercial gears. It developed, however, that the degree of accuracy required was higher than had been thought necessary. More trouble occurred due to improper tooth forms making lubrication of the teeth impossible under very high speed and pressure conditions existing. Distortion of parts under load has brought about trouble due to unequal distribution of stresses. Excessive stresses have been mainly due to inaccuracy and distortion, although in some cases undoubtedly better results would be obtained if lower unit stresses had been figured. However, these factors have been pretty well worked out and there is no reason to doubt that with simple gearing, leaving out freak designs, reliable equipment can be built. More attention will have to be paid to accessibility of parts and I have no doubt that the geared turbine will be brought down to one or two very simple and reliable designs.

One of the most difficult problems to overcome, however, and one one that will take some years to solve, is the lack of experience on the part of the personnel with high speed machines. A man accustomed to a reciprocating engine is usually lost with a high speed turbine and gear and until the operator obtains understanding of the fundamentals of such equipment there will be trouble due to burned out bearings, etc., which is not due to design but simply improper handling. On land, due to the fact that we have been using turbines for many years, we have educated a group of men who are capable of looking after machinery of this type and gradually such a class of operators will be educated for sea service. The use of the geared turbine enables moderate propeller speeds to be used with good propulsive efficiency and at the same time the natural speeds of the turbine can be used, and it may be stated in general, the geared turbine operates with about 25 to 30 per cent less steam than the reciprocating engine.

It is necessary to say a word in this connection about one of the main factors on shipboard with steam drive, which is frequently overlooked by the uninitiated and that is the auxiliaries. At the same time as geared turbine as introduced, small turbine driven auxiliaries were put out and in addition to the troubles caused by the new type of main machinery, there were a whole flock of new difficulties caused by these small machines. In the case of reciprocating engines, the wet air pump and the ordinary centrifugal circulating pump had been driven either from the engine or by separate reciprocating engines and the whole scheme of things had been worked out over a long period of years so that the equipment was simple and well understood. With high speed geared auxiliaries experience had to be gained not only in design but also in operation and this added to the problems of the main machinery and increased the difficulty of securing the reliable operation absolutely essential for ships. I think in the main that the difficulties that have occurred with the auxiliaries have been due to its mistaken idea of attempting to make them too light. Experience has shown the undesirable features and they have been corrected.

In this connection it might be stated that a great bulk of the geared turbines built in this country were designed by people familiar with land practice but not primarily marine engineers. They had impressed upon them the necessity of reducing weight and this feature was over emphasized so that in many cases they were led into designs which, if 10 to 20 per cent more material had been used, would probably have operated very satisfactorily. It is not always obvious that land practice cannot be followed but one has to learn the swell of the sea to understand the conditions and do the little things that are essential to successful designs.

As far as inland waterway transportation is concerned, the same principle as to the type of ship applies as on the high seas. The ship must suit the traffic. There are some features which make propulsion machinery simpler for ships intended for Great Lakes traffic than ships going to sea. The difference between salt and fresh water affects you in all kinds of ways. With ships going to sea, all parts in contact with salt water must be of some form of brass or copper, otherwise they would be rapidly destroyed. Of course, salt water cannot be used in boilers so that you are immediately forced to use surface condensers and distilling apparatus for make up water. In Great Lakes traffic we do not have anything of this kind and it simplifies auxiliary machinery to that extent. Except that ships are affected by the kind of traffic and the port facilities, Great Lakes shipping is no different from high sea shipping.

REDUCING THE COST OF STEEL-FRAME BUILDINGS

By R. Fleming*

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The purpose of this paper is to present a study of the question,—Can the steel-frame of buildings be reduced in cost without lessening their efficiency? The question will be considered mainly from the standpoint of the structural engineer.

Present high prices are not ephemeral. There will probably be declines that in exceptional cases may be quite marked but economists scout the idea of a general return of prices to pre-war levels for many years to come. Any immediate reduction in cost must be effected in some other way than by a decline in prices.

The main factors entering into the cost of the steel frame of a building are: base price of material, the building code, design, fabrication, transportation and erection. The structural engineer has little to do with the base price of material but his design determines the quantity and his specifications prescribe the kind of material to be used.

ALLOY STEELS

Here the question may be introduced,—Can alloy steel be used economically in building work? While the subject of alloy steels for bridges has been under considerable discussion but little, if any, attention has been given to their use for buildings. If economical for bridges may they not also be economical for certain parts of building work, as heavy girders or the columns of many-storied office buildings? for industrial buildings it may be economical to use longer spans. Alloy steels are more expensive than the ordinary kind, but higher working stresses are permissible and hence less material is required. Will the saving in weight compensate for the greater price per pound?

THE BUILDING CODE

The majority of steel frames for buildings other than industrial are located in cities having a building code. Many of these codes contain requirements more severe than necessary. The prescribed floor loads for office buildings are a striking example of the wide variation of our municipal building laws from normal requirements. From a tabulation made three years ago of the codes of 130 American cities, it is learned that two cities—Milwaukee and Fort Worth—specify 40 lb. per sq. ft. live load for office floors; ten, including Chicago and Cincinnati, 50 lb.; sixteen, including New York and San Francisco, 60 lb.; one, East Orange, N. J., 65 lb.; seven, including Denver and Pittsburgh, 70 lb.; fifty-eight, including Baltimore and Providehce, 75 lb.; one, Cleveland, 80 lb.; one, Youngstown, 90 lb.; and eleven, including Boston and Philadelphia, 100 lb. Since this tabulation was made, Boston has reduced the live load to 75 lb., and Pennsylvania has passed a state law requiring the live load on office floors to be not less than 60 lb. per sq. ft. The writer thinks 50 lb. per sq. ft. live load an ample provision, 60 lb. slightly in excess and more than 60 lb. a crime.

A similar variation exists in the prescribed loads for the floors of dwellings, ranging from 25 lb. in Fort Worth, 30 lb. in Milwaukee and San Diego, 40 lb. in Chicago, New York and others, a long list of 50 lb. and a still longer list of 60 lb. To require 60 lb. live load for floors of dwelling is absurd. A live load of 40 lb. for ground floor and 30 lb. for the floors above is sufficient.

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The same lack of uniformity exists in the requirements for the floor loads of other types of buildings. The writer has gone into this matter in more detail in an article, "Suggested Reform in Floor Load Requirements of Building Laws," *Engineering News-Record,* June 27, 1918.

A fertile field for variation and vagaries is the matter of wind pressure and wind stress. An examination some five or six years ago of 120 codes showed to the writer what seemed to him nearly every practicable variation. At that time he suggested as a basis for uniformity and sane practice the building ordinances of Chicago. The paragraph on wind resistance requires all buildings to be designed to resist a horizontal wind pressure of 20 lb. per sq. ft. of exposed surface. The paragraph relating to wind stress allows the working stresses given elsewhere in the code to be increased 50 per cent for wind forces combined with live and dead loads, but no section shall be less than that required if wind forces are neglected.

Again, specified working stresses are frequently not up to date. Some codes limit the unit stress for tension in flanges of built-up girders to 14,000 and 15,000 lb. per sq. in. of net section and shop rivets to shearing and bearing values of 10,000 and 20,000 lb. per sq. in. One code allows but 7,000 lb. per sq. in. shearing value for the webs of plate girders. More than a score of codes require brick enclosure walls that are entirely carried by steel beams to be more than 12 in. thick for buildings over 75 ft. in height. Such a provision means unnecessary steel as well as brick. The engineer who designed the steelwork of the Hotel McAlpine in New York City estimated that 800 ton of steel could have been saved but for this provision. As the code stood at that time, exterior walls carried on beams or girders were allowed to be 12 in. thick for the upper 75 ft. of height, but each 60 ft. section below this was required to be 4 in. thicker than the section above. The requirement frequently found of 8 in. firtproofing on the outer surfaces of columns in exterior walls places the columns 4 in. farther from the building line than necessary, increases the eccentricity of the load on the columns from the spandrel beams and adds to both the brick and steel required.

In most cities a committee could profitably be appointed for the purpose of revising the building code by omitting all unnecessary requirements and modifying those that are needlessly severe. In many cities because of the rapid growth in population during the past ten years the code has become inadequate and should be rewritten. The 1920 census shows surprising increases in population over the 1910 census. Akron, Ohio, jumped from 69,000 to 208,000; Bethlehem, Pa., from 12,000 to over 50,000, and scores of small towns have become cities, all of which emphasize bringing the local building code to fit new conditions.

The Technical Committee of the National Federation of Construction Industries is making a study of the building codes in the various cities. They propose a tabulation of the allowable stresses in concrete, lumber, gypsum, tile, brick and steel as permitted by the various building codes. The waste of material in many of the cities where obsolete codes exist will be shown by a comparison with stresses allowed by accepted authorities and more modern codes.

THE DESIGN.

The designer may space his trusses, beams of columns so far apart or so near together that they are uneconomical in the weight of steel. He may be unwise in choosing a type of truss, may use poor judgment in assuming loads and unit stresses and may be unduly rigid in his specifications, all of which will probably add to the cost of the building.

However, it should be remembered at the outset that a lessened weight of steel does not necessarily mean a lessened cost of building. If foundations are difficult and expensive it may be economical to use fewer and increase the weight of steel. Again, it may be cheaper to increase weight in order to secure greater duplication. If 2½x2, 2½x2½, 3x2, 3x2½ and 3½x2½ inch angles are shown on a design, three of the five sizes should be eliminated. Rafters, instead of trusses, at the ends of an industrial building weigh less than full roof trusses but the trusses by their saving in detailing and duplication in fabrication will usually be cheaper besides being better for any future extension that may come up. Beam work is fabricated cheaper per pound than riveted work, hence it is often cheaper to increase the spacing of trusses. This decreases the proportion of weight of riveted to weight of beam work. It also decreases the number of pieces to be handled. Work done in the forge shop such as bent plates, crimped angles, and upset rods are highly expensive and should be avoided where practicable. The fewer members in a truss the cheaper it is fabricated. The writer recently reduced the nine web members in a large number of saw-tooth trusses to two. About 15 per cent was added to the weight of each truss—mostly in the top chord to provide for bending stresses—but it was necessary to do so to lessen the work of fabrication. Rolled steel slabs in place of riveted bases attached to columns can often be used to advantage. (Rolled slabs are cheaper than forged slabs, castings or built bases, but forged slabs and castings can sometimes be obtained more quickly.)

A question presented for serious consideration is, whether the usual working stresses for steel in building work can not safely be increased to, say 18,000 pounds per square inch for tension and the equivalent in compression. During the past few years processes of steel manufacture and workmanship in fabrication have greatly improved yet we are still using the same working stresses as we did twenty years ago. Has not the time come to raise these time-honored stresses? By doing so, the weight of steel required would in many cases be lessened.

Questions in design are always presenting themselves to the structural engineer. It has been suggested to the writer that columns in many-storied office buildings may sometimes be advantageously made in three-story lengths.

THE DETAILS.

The detailer plays a more important part in determining the cost of fabrication and erection than is usually recognized. The present scarcity of labor makes it imperative that the largest possible tonnage should be turned out with the least number of men. With this end in view the following rules for detailing (taken from various sources) are given:

Floor joists, if possible, should be framed into beam and plate girders so that they are coped neither top nor bottom.

All unnecessary bevel cuts on plates and angles should be eliminated.

Do not use unnecessary rivets in fastening together the component parts of columns and girders.

Stiffener angles are to be omitted on columns under beam and girder seats unless the load exceeds 20,000 pounds.

Bracing connections that will necessitate cutting and splicing of web plates and slotting of cover plates on columns should be avoided.

Re-entrant cuts should be avoided.

Do not use unnecessary countersunk and chipped rivets in fastening cap plates and base plates to columns and base plates to girders and pedestals.

Both shop and field rivets are preferably driven by machine and if possible should be so located that the machine can be used.

On mill buildings when purlins are bolted, purlin clips and rod connections may also be bolted.

Avoid slight variations in details.

Avoid different sized holes in the same piece.

See that ample clearances are allowed.

Girders which frame into webs of columns should have when necessary, their flanges notched to clear rivet heads in outstanding legs of columns. This will permit erection without spreading of columns.

Entering connections should be avoided.

If practicable ,arrange details of a member so that it may be reversed in erection.

Make field riveting a minimum. Consider how each bolt and field rivet will be entered and fastened.

Of course these directions cannot always be followed literally. The system of fireproofing for floors may be such that coping of joists can not be avoided. An industrial building covering a large area is now being eretced. The purchaser wanted an economical building and an unusually quick delivery. He realized that it was no time to insist on little niceties and refinements in details. So gusset plates were made rectangular and angles cut square. This included hundreds of knee brace connections. So effective was this method that more than 1,000 tons of steel were on the ground before the foundations were ready. The purchaser will get his building on time.

By careful study considerable can be done in lessening the number of shop rivets in compression members. The time has gone by when a draftsman for lack of knowledge can space rivets 3 inches apart. The long standing requirement in specifications that the maximum pitch of rivets shall be 6 inches must also go. Of course rivets should be spaced to develop the direct and bending stresses involved. But for rivets not subject to any calculable stress and that are used only to fasten together the component parts of a member where loading is symmetrical, the writer would like to see fairly tried the following specifications (prepared by F. L. Castleman, Plant Engineer, American Bridge Company, Pencoyd, Pa.):

COMPRESSION MEMBERS.

The rivets through cover plates should be spaced in the direction of the stress not farther apart than 16 times the thickness of thinnest plate involved, plus 2 in., with a maximum spacing of 9 in.; at right angles to the line of stress the rivets through cover plates should not be spaced farther apart than 32 times the thickness of thinnest plate, plus 2 in. The distance from rivet lines to edge of cover plates should not exceed eight times the thickness of plate plus 2 in. Where a channel is used as a cover plate the rivets through the channel should not be spaced farther apart than 12 in.

The rivets through web plates and angles where web is enclosed between two angles, should not be spaced farther apart than 12 in.

The rivets fastening together the angles of a two angle strut separated with washers should be spaced a maximum distance apart of 2 ft. 6 in.

The rivets fastening together the angles of a two angle strut, angles in contact without washers should be spaced a maximum distance apart of 2 ft. 0 in.

The pitch of rivets at ends of compression members should not exceed four times the diameter for a distance equal to $1\frac{1}{2}$ times the width of the member.

At points where loads are applied to compression members and where compression members are subject to bending stresses, the pitch of rivets should be increased so that sufficient rivets are provided to distribute the load and to take care of stresses involved.

It may be said that these specifications have been followed with good results in riveting a number of heavy columns, symmetrically loaded.

FABRICATION.

The cost of fabrication depends largely upon the layout, equipment and management of the shop. The layout of the ideal shop and yard is such that material passes from the receiving yard to the shipping yard through all the different operations with a minimum amount of handling. The equipment of the ideal shop consists of the latest and best labor-saving devices properly arranged. The management should be in the hands of a superintendent having expert knowledge of men as well as processes and machines. Many plants have grown from small beginnings and hence are not ideal in their layout. Interior columns may be in the way of handling long pieces or insufficient headroom may prevent the installation of a desired overhead crane system. Disadvantages like these have been partly overcome by superior equipment and skillful shop management but they still remain more or less a handicap.

With the processes of fabrication and the economics of shop management the engineer, as such, has little to do. Both designer and draftsman, however, should have a competent knowledge of the shop equipment that they may be guided by its limitations.

STANDARDIZATION.

One secret of reducing the cost of fabrication is standardization. A report to the last meeting of the American Concrete Institute by their Committee on Standardization is so suggestive that it will be liberally quoted: (Concrete, March, 1920, page 146).

In the early days of structural steel each rolling mill had its own rolls, which varied in small details from those of every other mill and which covered an enormous gamut of sizes. Designing engineers in striving for economy, as they thought, called for sizes varying by a few pounds weight for each slight variation of load to be carried, with the result:

1—That the engineering cost was more expensive than necessary.

2—The tonnage output of the mill was reduced, owing to the innumerable changes of rolls required.

3—The work of the fabricating shop, together with the opportunity for error, was greatly increased owing to the possibility of mistaking one section for another which differed only in minor degree.

It was, of course, difficult to get material from several different mills and use it interchangeably, because of the lack of standardization. It soon became apparent

that the multiplicity of shapes and weights put a tax on the use of structural steel that was unnecessary and undesirable. As a result, the decision to roll only certain shapes and weights was reached, and designers were compelled to adopt these shapes and weights to their use.

Needless to say, a good deal of agitation and misgiving was occasioned, but today we know that the change has been justified, that the smaller number of sections to be obtained are nevertheless sufficient for any case that may arise and that economy has gone hand in hand with change.

The standardization of structural steel is but one example. This has been extended to steel sash and other itmes used in the construction of buildings.

The lack of standardization, with its attendant bothers, is clearly shown in the products of the various brickyards, hardly any two of which produce brick of a size and color so nearly alike as to enable them to be used interchangeably with the bricks from another yard. In a time like the present, when there is a decided shortage of brick, this condition is an unmitigated hardship.

Citing again the steel sash shapes as an example of the tendency toward standardization, just so long as the regular stock sash with flat heads and horizontal pivoted ventilators are ordered a reasonable time of delivery may be obtained. If, however, to satisfy a whim of the owner or engineer, vertically pivoted ventilators are called for, the whole operation of the shop is thrown out of gear.

In 1916, on an average job, a division of the money spent in producing the structure would indicate that labor cost about 30 per cent and material purchased about 70 per cent of the total. Today the division would be approximately 40 per cent for labor and 60 per cent for materials, and it is predicted that in the near future, owing to the rising price of labor, this division will be more nearly 50-50. As the labor cost increases it becomes self-evident that more and more material can be used, if thereby labor can be reduced.

A few specific instances of details that apparently economize but actually add to cost will be indicated.

Blue-prints for a building recently submitted showed a total of 54 footings. These footings were in the form of truncated pyramids with a square or rectangular base. Slight variations in the size and shape of the base and of the top on which the column rested resulted in nineteen separate types of footings. Of this number, fourteen occurred once, two occurred twice, one three times, one occurred five times, one twelve and one sixteen times. The footings as detailed doubtless save some concrete over that required by simple steps, but the saving was made at the cost of some very fussy and expensive form work.

In this connection mention should be made of the efforts now being made to secure common Anglo-American rolled steel shapes. When the object is accomplished standardiation will have been carried to a point unthought of but a few years ago. (See Report of Committee, *Proceedings, Am. Soc. C. E.*, Vol, 46, Aug., 1920, page 577.).

TRANSPORTATION.

At first thought it might seem that the cost of transportation was a fixed quantity and did not enter into the subject of reducing the cost of steel frames. Such would be the case if all material were shipped at car load rates. But to secure

these rates it is necessary that cars be loaded to a capacity fixed upon by the railroad company. This can not always be done, especially with roof trusses, on account of the length of members. The question continually comes up: Is it cheaper to send trusses more or less "knocked down" in car load lots to be assembled at the site or to send full trusses at heavier freight charges. An instance of what is meant will be given. A recent contract for an industrial building included more than 100 roof trusses of 60 ft. span. The freight rate from fabricating plant to destination was 25 cents per hundred pounds plus 3 per cent war tax. The cost of loading and transporting full trusses was as follows:

SCHEME NO. 1.

Single load (one car), 15 half trusses.
Weight 2,200 lbs. each—33,000 lbs. total.

Cost—Blocking material and bracing rods....	$ 7.84
Labor in loading....................	19.85
Labor in bracing....................	9.80
Freight to destination..............	84.98
Total..............................	$122.47

equivalent to $8.16 per half truss or $16.00 per full truss. (The above were actual costs.)

SCHEME NO. 2.

Double load (two cars), 6 full trusses.
Weight 4,400 lbs. each—26,400 lbs. total.
Minimum weight on two cars for which charges would be made by the Railroad Company 54,000 lbs.

Cost—Blocking material and bracing rods....	$ 46.30
Labor in loading....................	11.90
Labor in bracing....................	14.94
Freight to destination..............	139.05
Total..............................	$212.19

equivalent to $35.36 per full truss. (The above were estimated costs.)

Each truss of Scheme No. 1—the scheme adopted—required 55 field rivets. It is hardly probable that the saving of $19.03 per truss over Scheme No. 2 would be absorbed by the erection department in assembling and riveting the half-trusses in the field. 'However," the shop superintendent writes, "we believe that there is a considerable saving in the shop in cutting these trusses. If they were shipped in the 60 ft. lengths it would mean that we would have 60 ft. of one side of our shop assembling a truss that weighs only about two tons, whereas in having them in 30 ft. lengths we can have two and three gangs fitting and riveting. By having this number of gangs we have gotten out 48 and 50 half-trusses a day."

From the above it is seen that to effect real economies a careful study must be made in each particular case of all the conditions: shop-handling, freight rates and erection.

Many directions might be given for loading and shipping. Experience is an excellent teacher. A number of years ago some heavy plate girders for a bridge were loaded so that when they arrived at the site they had to be turned end for

end. As there were neither room nor facilities for doing this it was necessary to draw the cars to the nearest Y, some 30 miles away, and there reverse. In another case several cars loaded with roof trusses were well on their journey when it was found that a bridge on a connecting road had not sufficient headroom to allow their passage. The cars were hauled back to starting point and sent by another route, which fortunately had no low bridges.

The shipment of material in the sequence of erection is a decided advantage to the erector but this can not always be done. "You haven't even shipped the purlins, you generally send them first," said an irate purchaser to the writer. Where shop and yard room are limited purlins are often shipped first to get them out of the way.

ERECTION.

One great opportunity of the draftsman is to make erection as easy as possible. Close fits and entering connections should be avoided. The caution regarding unnecessary shop rivets applies with added force to field rivets. There are many devices for attaching the work of other contractors that will eliminate drilling holes.

A decided reduction in the cost of erection can often be brought about by the use of bolts instead of rivets for field connections. The writer has given some study to this particular subject and presents his conclusions in an article, "Bolts in Field Connections of Steel-Frame Buildings," *Engineering News-Record* Aug. 14, 1919. The conclusions drawn are confirmed by a number of correspondents in subsequent issues of the periodical.

It is believed that bolted connections are permissible for the following:

Buildings of one story, not of great height and acting mainly as shelters. Such buildings carry no shafting or electric traveling cranes and unless exposed to unusual winds there is little reason why field connections may not be bolted throughout.

Buildings for temporary use.

Subordinate framing such as that required for stairs, doors, windows, partitions, ceilings, monitors, pent houses, curbs and railing. It is often desirable, if not necessary, to have framing around windows, doors, skylights and similar work bolted in order to secure proper adjustment for the work of other contractors.

Purlins and girts, except where they form an integral part of a system of bracing. There is little reason why the clips to which purlins and girts are attached should not be shop-bolted, instead of shop-riveted, to main members. The same is true of many connections for subordinate framing.

Platform and floor plates. If there are trucks moving on the floor, or there is shoveling of coal or material, countersunk-head bolts should be used. An indentation in the head is convenient to hold a bolt while the nut is being turned. In other cases bolts with button heads not over 1-4 or 5-16 in. high may be used.

Connections of beams to beams and beams to girders in floors that do not support machinery, shafting or rolling loads. This is an important item in a many storied office building or hotel. If the connections of floor members to columns are riveted the structure is stiff transversely and longitudinally. Little is gained in stiffness and such is added to expense by riveting connections of filling-in members. Moreover, in fireproof construction the bolts are embedded in concrete, a fact which

should assure any doubter that there is no chance of nuts becoming loose. The specification for a twelve-story apartment house in New York City has the clause: "All connections within 3 ft. of the column centers must be riveted. All tank and sheave beam supports must be riveted. Other connections may be bolted." In this particular building the beams upon which some columns depend for lateral stiffness do not connect directly to the columns, but frame a foot or two away into other connecting beams. Is not this a commendable cause for similar cases?

Bracing connections not subject to direct stress. This refers particularly to the intersection of bracing angles midway between trusses and columns. An over-zealous inspector will sometimes insist upon specifications being carried out to the letter and that rivets be used. This necessitates riveting from a special rigging at a cost of a dollar or two per rivet. The cost would not be a valid objection provided anything were gained by it.

Connections not subject to shearing stress at opints where members rest upon other members.

The foregoing list is a conservative minimum. In many cases it may be extended.

A question worthy of consideration is whether rivets for field connections of larger diameter than those in common practice cannot profitably be used. Theoretically, fewer are required. A 7-8-in. rivet has 36.1 per cent more shearing value and 16 2-3 per cent more bearing value than a 3-4-in. rivet. A 1-in. rivet has 30.6 per cent more shearing value and 14 2-7 per cent more bearing value than a 7-8-in. rivet. It would be interesting to have the larger rivets tried out in a case where the cost of field riveting enters unusually large into the cost of erection. It may be mentioned that 1 1-4-in. rivets were used for the field connections of the recently erected Cunard Building, New York City. The results were very satisfactory.

From different superintendents of erection the writer has obtained the following suggestions:

Use bolts wherever practicable.

Seats for beams and girders are often worth their weight in gold.

If it is necessary to have rivets at isolated points it is cheaper to drive two rivets than one.

More co-ordination with the erection department from start of design to finish of fabrication would be conducive to lessened cost of erection.

In through plate girders be sure that floor beams can be erected without spreading the girders. It should not be necessary to tip columns to put in place beams or girders.

Why change sizes for only a few rivets? In one building (with a Berquist bunker) there were 45 field rivets of 5-8-in. and 8,685 field rivets of 3-4-in. diameter, in another building 72 of 5-8-in. and 592 of 3-4-in. diameter and in a third building 16 of 5-8-in. and 354 of 3-4-in. diameter. In each of the three buildings it would have been cheaper to have had all rivets 3-4-in. diameter, even if their use had increased the sizes of some connecting members.

Purlins should be placed on the upper or peak side of clips. They are thus prevented from sliding down the roof before being bolted.

It is fundamental that foundations be brought to the proper level and anchor bolts be set correctly before the steel-erector is ready to begin work. Keeping a gang of men waiting or working at a disadvantage is costly.

Standardize erection operations as much as possible. To do so it is necessary that the engineering and fabricating departments have it in mind from the start.

For important buildings a special study should be made of the scheme of erection. Methods out of the usual may sometimes be followed to advantage.

THE TIME ELEMENT.

An element entering into the cost of steel structures that should not be overlooked is time. A structure wanted in an abnormally short time can usually be obtained only at an abnormal price. On the other hand, delays preventing normal procedure are always expensive. A delay may occur in furnishing complete information to the drafting room. Probably there is nothing that increases the cost of drawings so much as incomplete or incorrect information at the start. A change in a single figure is often far-reaching and the liability of error is great. Besides the morale of a drafting force is liable to be broken if called upon to discard work upon which much time thought has been spent. When it comes to fabrication some sizes may not have been received from the rolling mill which necessitates putting aside the members affected. The erector may be held up because of the non-arrival of pieces when needed. These delays all mean increased cost, for work in no department can be laid aside and taken up later without incurring expense. In addition there is the loss to the purchaser of the interest on capital during the time it lies idle and the loss due to the interruption of business. Indeed, the fourth dimension of the cost of structures, that mysterious path by which costs take wings and mount upward is *time*.

The claim that all advantages derived from lessening the cost of a steel structure accrue to the fabricating firm is true only for isolated cases. If methods tending to reduce cost be persistently followed a large part of the saving will in the end revert to the purchaser.

DISCUSSION

By Norman M. Stineman, A. W. S. E. (Written).

Mr. Fleming's paper points out the manner in which city building codes, with their many useless and unreasonable provisions, hamper the design and construction of structural steel buildings. The matter would not be so serious were it not for the fact that a needless waste of money is involved.

Other building materials suffer equally in this respect. Taking the single subject of unit stresses for reinforced concrete design, an examination of a number of building codes reveals the fact that for the equivalent of 1:2:4 concrete, testing 2,000 pounds per square inch in ultimate compressive strength, the allowable working stress for compression in extreme fibre varies from 500 pounds in San Francisco, Denver and Boston to 800 pounds in St. Louis and Atlanta. Allowable bearing varies from 400 pounds in San Francisco, Milwaukee, Chicago and Syracuse to 650 in Detroit, Louisville and Rochester. Allowable compression on concrete in plain columns varies from 400 pounds in San Francisco to 650 in Minneapolis. Compression on concrete in the core of a column with vertical and spiral reinforcement varies from 500 pounds in San Francisco and Chicago to 800 in St. Louis and a number of other cities. Allowable shear with full web reinforcement varies from 120 to 150 pounds, although fully 50 per cent of the codes examined fail to specify anything definite on this important point. In many codes the allowable bond stress is specified without a distinction between plain and deformed bars. Likewise, many codes specify 16,000 pounds per square inch in reinforcing steel, but make no distinction between the various grades of steel. High-carbon steel is entitled to higher working stress because it has a much higher yield point than the other grades. Cincinnati, Detroit, Newark, Rochester, St. Louis and Syracuse allow 20,000 pounds in high-carbon steel.

It is evident that in many cities the allowable stresses are entirely too low. Buildings are over-burdened with tons of extra material which is not needed and serves no useful purpose, but which adds to the dead weight and cost of the structure. The additional cost must be passed on to the public in the form of higher rents or higher prices for goods.

One great trouble is that the writers of many codes have gone into the minutest detail in an effort to cover all possible contingencies, instead of confining themselves to fundamentals. Other glaring faults are the inclusion of meaningless and irrelevant material, failure to assemble all provisions pertaining to one subject in one place, conflicting requirements, ambiguous statements, and lack of provision for new types of construction not specfiically mentioned in the code. These chaotic conditions arise from the manner in which building codes are usually developed. They are products of the scissors, to a large extent. Originally some one must have written a code; but later ones, when first prepared, were largely copied from those of other cities. Amendments were then added from time to time, and the resulting product left the reader in hopeless confusion.

A great need of the building industry is a standard building code in which only essentials are included and which may be applied with slight modifications to all sections of the country. While every city may have special requirements which need special treatment, such provision could be assembled in one chapter and kept apart from the standard code. There is no sound reason why the working stresses and specifications for materials such as structural and reinforcing steel should not be

uniform in all cities. Working stresses for concrete and certain other materials could be, and frequently are, stated as a percentage of the ultimate strength. Consequently they can be standardized. Thickness of bearing walls, non-bearing curtain walls and non-bearing partition walls might be held to an arbitrary thickness with some material such as brick, but there is no excuse for applying brick wall dimensions to newer types of material whose characteristics are entirely different from brick.

The question has been raised as to whether a standard code would be adopted. Several signs indicate that it would. For instance, the building codes of Boston, New York, Chicago and San Francisco are freely copied by the smaller cities in those districts. This indicates that building commissioners are inclined to accept what they consider an authoritative code. Another favorable sign is the manner in which the final report of the Joint Committee on Concrete and Reinforced Concrete, issued in 1916, has been accepted. Many recently revised building codes contain the substance of the Joint Committee provisions. Had the Joint Committee report been written in building code form, so that it could have been included bodily, its exact wording would doubtless have been adopted in many cases.

If a complete building code were prepared by some general committee of the standing of the Joint Committee just mentioned, and issued by some Federal Government bureau, it would in all probability be gradually adopted by our cities. This would remove one of the greatest obstacles in the way of standardization in the building industry.

THE RELATION OF STATISTICS TO PROFESSIONAL WORK AND INDUSTRY

By Horace Secrist*

Presented January 3, 1921.

The subject which I have chosen has many angles, and it is impossible for me, in the short period which I have, adequately to deal with the subject because of its wide ramifications, but there are certain phases of it which I will cover.

Statistics in its various aspects is very markedly coming into its own.

There is one thing that impresses me more as I study the subject of statistics and its application to professional work and to industry. It is the difficulty of drawing a line of demarcation between the various uses to which statistical data is put, either by the engineer, by the trained statistician, by the publicist, by the social worker, or by any other person who has occasion to use them.

The tendency is clearly toward the use of statistical data for the purposes of foresight rather than hind-sight. Before the war, statistical data was not used on a large scale by the Federal Government for planning purposes, but during the war, the Federal Trade Commission, the War Industries Board, the Shipping Board, the Army and the Navy began to use them for developing constructive plans and testing the degree to which these plans were realized in actual performance. The old idea was to regard statistics as records, and their analysis as a means of explaining past performance, but not as a means of determining future activity.

Statistical data of all kinds are now coming into use as means of charting a route, of laying plans, no matter whether they are associated with the acquisitive or pecuniary side of life, or with the broader and more fundamental condition of industry and professional work.

If you will pardon a slight digression here, there is one thing that I want to mention, because it is closely connected with what I shall have to say tonight. It is that the tendency in modern economic thought,—fundamentally and not superficially—is toward an economics of welfare and away from an economics characterized solely by acquisitive motives. Welfare is displacing acquisition as an economic end.

I was interested in what Mr. Nethercut had to say concerning the opportunities for public service through the offices and committees of the Western Society of Engineers. The same thing is showing itself in other fields of public endeavor. The economic thought of today is fundamentally concerned with economics of general welfare, but not to the exclusion of private welfare. It is hoped to realize the former through the development of private initiative. In a very true sense we are all on common ground.

As a matter of fact, even though I am not an engineer, I feel quite at home before this group, because I have the distinct privilege and unique opportunity of being a member of an engineering faculty and of listening to and taking part in discussions on engineering topics, particularly those relating to education.

You have been introduced to various kinds of statisticians tonight, or, rather, to various kinds of statistics. My belief is that statistics have been are are in dis-

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repute, in part, not because of the statistics, but because of the statistician. But those who are mentally derelict are not restricted to "statisticians." In all walks of life there is the charlatan, the faker, the person who doesn't know and claims, through bluff and innuendo, that he does know. I think possibly the engineering profession is not entirely free from such people and I am quite certain that they may be found among those who pose as statisticians and as economists.

False reasoning and unwarranted conclusions from statistical data, however, can no more be attributed to statistics as such, than poor workmanship and faulty bridge construction can be charged to the principles governing tensile strength or the law of gravitation. If the bridge collapses, the error lies in the ignorance or mistaken judgment of its designer, or improper use. Similarly, statistics themselves do not lie, but statisticians do.

But what are statistics? Statistics are simply tools,—quantitative tools—by which we form judgments, by which, on the basis of certain hypotheses, we test out theories, measure them, estimate the influences by which they are affected, and finally arrive at a decision, quantitative in character. The differences ar significant, and it is these which we express in actual quantities. in percentages, as ratios, and from which we form our judgments. These are statistics. They are no better than their makers, their users, or their compilers. There is the same distinction between the identity of a statistical fact and the conclusion which may be drawn from it as there is between the fact of the density of a material and the conclusions respecting its industrial use.

Statistical tools are quantitative. I remember a distinction made by Thorndyke in his "Mental and Social Measurements," that "the difference between two and three is not the difference between six and seven." Quantitatively, it is one, but as one it may have much or little significance, depending upon the use to which it is put, or the unit of measurement to which is applies.

If there is anything fundamental in statistics, it is the unit back of the quantitative expression. The significant thing is not so much the measure, in Arabic symbols, of a more or less, as it is the unit to which the quantity is applied, be it a ton mile, a sale, an occupation, a wage, a death, an industrial accident, or even a "successful engineer."

Things which are equal to the same thing in name are often not so in use, and things which are the same in use and meaning are oftentimes called by entirely different names. The most significant thing in statistics, as a tool in the development of the logical processes of thought, is a clear definition and the standardization of units. You, fortunately, have the units which you use pretty well perfected. Yet, undoubtedly, you do not all agree upon their meaning and use ,except for the more common ones of length, etc. You are constantly seeking for new and more refined ones in which to express and measure new forces. Similarly,—but not with the same precision—the statistician and the economist who is dealing with industry and economic forces are searching for units of measurements in which to express industrial and social forces and phenomena.

If statistics is, primarily, a tool and units are the blocks with which the statistician builds, then the whole statistical process is largely one of logical education.

The good statistician is the person who insists that the units of measure with which he works shall be accurately defined and clearly applied to the problems which he is studying; who draws a logical conclusion from the data at hand and is

fearless enough to insist that the action toward which his conclusion points, actually taken. It makes no difference whether it has to do with realty valuations, valuation of public utilities, the measurement of the cost of living, or industrial efficiency; the method is the same. It is the process of logical deduction from sample data—a method not peculiar to the statistician, but universal. It is the process which you employ in your engineering fields.

Now let us consider a thing with which you men, as engineers, are all familiar. You have been reared on the so-called scientific method. The claim has been made, of course, that the social sciences are not sciences, because they cannot predict, and that they are not exact in the same sense as are the physical sciences. From that standpoint they have their limitations, but as a classified body of knowledge, with which we are working,—as the engineer is working with his data,—to discover the fundamental laws back of human activities, they are sciences in a very real sense.

Karl Pearson, the English biometrician, in his "Grammar of Science," with which you are probably familiar, says "that the unity of all science consists alone in its method, not in its material." Moreover, he says that the real justification of the scientific method in business, in industry, in studies of life and death and birth, etc., is that it makes a person a better citizen. Citizenship, he continues, is good or bad in proportion to the degree to which there is discrimination between things which seem to be and things which are. "The classification of facts, the recognition of their sequence and relative significance is the function of science."

I have a thesis which I have developed in various places in what I have written, viz., "that the real scientist is the person who sees differences." To you the real scientist may be the person who sees similarities, but to me he is the person who sees differences. I walk through the forest and see an oak tree. I can distinguish it from the maple, but hand me two oak leaves, and my power of discrimination vanishes. To me, they are essentially identical; to the bontanist they are entirely different. To me all engines are pretty much the same. I could distinguish them in a general way, but to the engineer, the mechanism, the principles upon which they operate, the underlying theories upon which they are constructed, are all different. The real engineer is he who sees the differences and because of his power of discrimination, discovers new principles and new truths and applies them.

Now it seems to me that this approach to the study of life, applies not only to the engineer of mechanical, civil, or electrical bent, but also to everybody who really attempts to be scientific in his attitude.

Let me briefly analyze the essence of scientific method into its component parts. What I am about to say was not prepared with the problems of the engineer in mind. I have said, in substance, what I am saying tonight, before advertising clubs, civic clubs, and others, and it is just as good doctrine for you, as it is for them, in spite of your specialized trfaining. The real essence of scientific method, the substance of statistics and the measure of the statistician is, first, intelligent observation.

In recommending a sales campaign or a sales analysis, it is impossible even to start without intelligently observing the differences between goods, between people, and between strata of society. To make allowance for all differences is, of course, unthinkable—these are infinite. People are not identical in their reaction to advertising, to bargain sales, and the clever tricks of salesmen. They have different in-

comes, peculiar racial and customary traits and prejudices. They fall into strata of different depths and contours. A market is not a homogeneous thing geographically. In one place it is deep, as it were, and fertile; in another, shallow and sterile. To advocate an advertising or a sales campaign without first considering such fundamental differences as the reaction of people to different kinds of goods is grossly unscientific. To do so is to ignore significant differences and to violate a fundamental principle of scientific method.

The first and foremost condition of being scientific is to observe intelligently. But that alone will not suffice. Scientific measurement is indispensible. In the engineering field, I imagine—and here I admit I am on dangerous ground—a certain leeway is made for the personal equation. I think my friend Professor Hayford, in his book on "The Adjustment of Observations" calls attention to this in the discussion of the theory of least squares. Obviously, we have to take account of the personal element in scientific measurement, when applying the principles of statistical science to business problems. Scientific measurement involves the use ot a unit. The statistics of transportation in America are being revolutionized through the creation of fitting units of performance ;through the selection, for instance, over and against the old ton mile, of a variety of modified units, which indicate the drawbar pull on the engine per unit of coal consumption, etc. Standards of this type are necessary if we desire to measure accurately operating efficiency.

Tons of freight are not identical except as to weight, in the economy of transportation, nor are all miles the same from the standpoint of operating efficiency. Accordingly, as you all know, comparisons, upon a ton mile basis, made between railroads are often meaningless. One would hesitate to compare in this manner the Illinois Central with the Norfolk & Western, or with the B. & O., east of Pittsburgh. But still we have to use these units. The more carefully we can measure them, however, and the more complete the similarity of the conditions under which they are used for comparative purposes, the greater is the chance of the results being significant.

The same principle holds true in cost accounting. This is a field which is just being opened up and which has as great an interest for the engineer, as it has for the economist. If costs are to be accurately determined, the use of composite units cannot be tolerated. Only those which have been reduced to the lowest denominator and standardized, will reveal actual and comparative costs. The same condition holds in statistical analysis. If, analogously, we are content to use a hammer when we need a saw, or a saw when we need a planing mill—a practice which characterizes far too much our rough and tumble economic thought—obviously, we are being grossly unscientific.

Now, the engineer—particularly the industrial engineer—is seeking for units which will measure fatigue, industrial morale and fitness, and the effect on production of a shortened work day. The significance of the problems which these subjects suggest can hardly be bounded by any narrow ring fence. The conditions under which production is carried on, such as the uniformity of the power and the technical features of the machine have an engineering significance. The training and fitness of the operator are of interest to the economists, while the chemical composition and uniformity of the material with which he works, raise problems with which only the chemist is competent to deal.

In all fields scientific inquiry rests fundamentally on the adequacy of units of measurement. The problems may involve the collection of units for determining

accident frequency or severity rates in industry, or of fixing the responsibility for accidents as between the machine, the carelessness of the operator or low morale. No matter what the field of study, every logical process is interwoven with the need for a unit of measurement.

I have said that the first condition of being scientific is to observe intelligently. Following this, but of no less importance, is scentific measurement. The next step —impartial analysis—hinges on both. The engineer in his technical research, or the statistician in the analysis of the market or in the determination of reasonable rates, wages or earnings in public or private enterprises, must proceed on the basis of impartial analysis. Most of us, as a matter of fact, think in general terms; we are prejudiced; we have our minds made up. Our opinions rest on faulty evidence. We hesitate to examine impartially every issue which is raised. It is so much easier to assent, or to dissent, and to take refuge behind our ignorance or our willfulness, by exclaiming "This is my opinion." To do this is to reject a fundamental of scientific method. The real engineer like the real statistician is one who respects the truth, and who, impatient though he is until it is discovered, knows no other method than that of impartial analysis.

Having defined the part which observation plays in scientific method and in its application to industry and to professional life, I must insist upon another condition by which the seeker after truth must be guided. It is that of logical inference. In spite of the presence of satisfactory facts, unwarranted conclusions may be drawn because of illogical inference. Contrariwise, on the basis of faulty data, the truth may be discovered, if their peculiarities are known, or if allowances can be made for them.

Let me give you some illustrations. During the period 1903 to 1908, I had the privilege of working with the Wisconsin Tax Commission in the perfection of the so-called "sales method" of evaluating real estate. Time and again, the question arose as to the number of sales which is necessary in order to determine the value of the real estate in the tax districts of Wisconsin. On the basis of our analysis it was not long before it was possible, by the use of a half a dozen to ten sales for a given district and from the offices of the Commission at Madison, to determine with accuracy the value of real estate in a given county. Why? Because the elements of error characterizing sales were known and allowed for. Bias, whether due to the presence of land contracts, quit-claim deeds, or clouded titles could, on the basis of past experience, be removed. Even though the data was faulty, when each item was taken by itself, it was possible to secure accurate results within a margin of error which, for the purposes in question, could be ignored.

Another illustration. On the basis of the prices of thirty-six commodities, Professor Fisher, of Yale, has been able to construct essentially as satisfactory an index number of prices as has heretofore been possible by using some 360 commodities.

Again, Professor H. L. Moore, of Columbia, on the basis of rainfall alone, has more accurately forecast the production of cotton in the South in each of the years from 1877 to 1912 than was done by the Department of Agriculture two months before the cotton was harvested. How did he do it? The mathematical processes of correlation sufficed for this purpose. In spite of the limitations of his data and the fact that other causes than rainfall contribute to cotton production, a logical inference from the data available put him within a negligible margain of the truth.

The illustrations of logical inference which I have cited rest upon the application of mathematical processes. But such is not always, nor necessarily, the case. One does not have to be a mathematician to reason closely or to draw sound conclusions. What is always required is a decent respect for the truth and a willingness to accept it in whatever form it may come. The demands are equally binding upon all professions. It is no different for the statistician than for the engineer.

Let me hazard an illustration from the engineering field. The question arises as to the cause for the slides at the Panama Canal. The engineer collects his data, all the time insisting upon the accuracy of his units and the preciseness of his measurements and from them draws his deduction by the same logical process that is used in analyzing a mass of data in the business field to determine the effect of a change of business policy, to map out a business program, to correct an abuse, to stop a leak in expenditure or to measure demand for a product. "The unity of all science is in its method."

There is one more step which must be taken in the process of scientific analysis. Application or use must be made of the conclusion reached. It is not enough to infer logically on the basis of given facts; action must be taken. Now most statistics, if they are not dead when collected, soon die. Most of them are for file and not for use. That is unfortunate. Much data which is collected in the engineering field, I imagine, is for file and not for use. Why? Because they do not pan out, because, having been collected without a definite purpose in mind, they do not point to tangible results. Application is unwarranted. But are statistics to be condemned or inquiry halted because of the fruitlessness of unguided or misguided efforts? The fault, if fault there be, is not with the statistics, but with the statistician.

For purposes of summary let me enumerate the steps in scientific method which apply with equal force both to the engineering and to the business field.

First, intelligent observation; second, scientific measurement; third, impartial analysis; fourth, logical inference; and fifth, the application of the results to a given condition.

The goal of statistical study is comparison. But comparisons are restricted to things which have points in common. A comparison between the construction of a gas engine and a person's reaction to an advertisement would, of course, be ludicrous. Yet comparisons involving things which have almost as little in common are currently made.

Let me call your attention to one. In 1914, while I was with the United States Government, I stopped three weeks in Harrisburg, Pa., to study the statistical side of the crusade for industrial safety. On the basis of certain statistical data, the conclusion had been reached that the high accident rate, in a particular industry ,was due to the fact that the machines were unguarded, and legislation was passed requiring certain of them to be guarded. No study had ever been made to determine in how many accidents, the proximate causes of injuries were faulty lighting, lack of intelligence on the part of the individual, or inability to speak English. A person in a responsible position told me that in his judgment millions of dollars had been expended on machine guards for prevention of accidents, when the real cause of accidents could not be traced to the machines, but to the low intelligence of the workman and his home surroundings.

Let me repeat. The goal of statistical study is comparison. But for this purpose, the facts which are used, that is, the tools, must be representative. Rarely,

if ever, is a study made—engineering or otherwise—in which all the facts or data are available for use. Samples must be selected. But upon what basis are they to be chosen? Other things being equal, the more complete the sampling, the better the data. If they are truly samples, those selected must partake of every characteristic found in the complete data. Moreover, every characteristic must have a chance of being included in the proportion in which it exists when all items are considered. In how many cases, where samplings are made in the engineering and businss field, is it possible to duplicate the homogeneity which characterizes the samples used by the chemist?

How many samples are necessary in order to study industrial fatigue? How many are needed to study any of our basic trade customs, or even to measure such a seemingly tangible and fundamental thing as price change. The answer is found in the preciseness and the representativeness of the data selected. At all events, the data must fit, they must be germane to the particular problem, and this is no more true in the statistics of business than it is in the research or practical aspects of engineering.

Moreover, statistical facts must be stable, their identity must be preserved, if they are to be used for comparative purposes. That this is true may be illustrated by reference to the difficulty of comparing prices of different commodities over a series of years. The prices of production goods react differently from the prices of so-called consumption goods under conditions of shifting demand. The prices of mineral products, other things being equal, are more stable than are animal products. If prices which are supposed to represent a market are selected over a series of years without reference to the peculiarities of manufactured commodities as distinct from raw products, from mineral products as distinct from animal products, the conditions which are represented are unstable, both as to the character of the goods and the period which is covered. To dip down in the sea of prices in order to select a sample, is far different from selecting a small quantity of a homogeneous liquid for analysis. To do one is not to do the other.

Statistical data, to be of value, must be comparable. Prices of today are not fully comparable to those of the war period, because methods of purchase and sale, of credit extension, and governmental control at the two periods are different. The greenback prices of the Civil War period are not comparable with those following 1879. Prices in England now are not fully comparable with those before the war. Prices, in England, are now calculated on the basis of a paper standard. Before the war they were based on a gold standard.

Comparisons are always made on the basis of data which are imperfect in some respects. Absolute identity is probably never realized. Nature exhibits herself in variety, and so does business. Men and institutions vary from place to place, from time to time, and from environment to environment. Even in the so-called exact sciences, the exactness is relative and never absolute. But in all fields of study it is possible to have, and necessary to insist upon having, essential homogeneity. Accuracy and comparability characterize the data which is used. Of course these standards are daily being sacrificed and ignored by the expert, as well as by the layman, with the consequence that statistics are in disrepute, the work of statisticians discounted, and business conducted, for the most part, on the hit or miss, catch-as-catch-can method.

Of course, there are different kinds of statisticians. If one desires to prove a thing, or to support by statistical evidence a pre-conceived conclusion there are

plenty of data which will be of service to him. The idea that statistics are dangerous because by them one can prove anything, is sound. You can, if you select your material. One can demonstrate that butter is harder than steel if he selects his data with this end in view. It would only be necessary to compare molten steel with frozen butter. But this you say is nonsense, and so it is. Nevertheless, it is symbolic of comparisons which are currently being made on the basis of "statistical" data, and the results of which are gullibly consumed by the unsuspecting public. But this is not the fault of statistics; it is the fault of the statistician. He is either ignorant or willfully malicious. Statistics should not be condemned. The person who presents them should be held to the standards of scientific method and those who use them should be educated. *t*

I am not going to burden you with a discussion of the technical processes of tabulation and graphic analysis, or of their abuses, but I do want to speak of the interpretation of statistical data.

Let me briefly recapitulate what I have said up to this time. I have tried to make it clear that there is a common bond between the use of quantitative data for statistical purposes, and the use of the same kind of data for engineering purposes. Both uses involve an application of the scientific method in the discovery of truth. Both involve the use of units of measurement. The engineer thinks in terms of the foot, the mile, the meter, the rod, the kilowatt hour, the ton-mile, and other complex units. The statistician thinks in terms of the dollar, price demand curves and price supply curves, and markets. These are the units which are utilized for purposes of analysis. The method which is pursued in the engineering, the educational, and the business field is identical in that it involves, on the part of the investigator, intellectual honesty and unconditional demand for the truth. It requires intelligent observation, scientific measurement, impartial analysis, logical inference, and an application of the inference to the problem to which it relates. To stop short of the application is to sacrifice art to science, when it is possible and desirable to realize both.

A great body of data is available for analysis. The data may relate to rainfall, weather conditions, evaporation, movements of the crusts of earth, drainage, etc. They have been carefully selected, are definite, they "fit," they are applicable to the problem which is being studied, and ar fully comparable. They have been properly classified and grouped, and are ready for interpretation. To what standards must an interpretation of them conform?

Comparison must be made between data having parts in common. That sounds trite, I grant you, but if you will think of what it implies, you will easily recall from your everyday experiences instances where comparisons are made in complete violation of it, and on the basis of which money is expended, and business policies and plans altered. Data may be different or incomparable because of differences attributable to place. Wages in England may hardly be compared with those in Chicago. Why? Because, after full allowances are made for conditions which are different, the points in common are negligible.

Moreover, time differences may destroy comparisons. Personally I look with suspicion upon comparisons which extend over a period of time. Take for instance, a comparison of stock and bond prices over a series of years. Have the stocks and bonds retained their identity? What effect on the original issues has been produced by the floating of new securities? What has been the effect of increased capitalization? Has the thing in which you have property rights remained the same in spite of the changes? It is still called by the same name, but all would agree that it is different.

I want to mention again the fact that every comparison must be referred to the condition that can produce it. Grave statistical errors have resulted from comparing things which are different, or conditions which could not produce the factors being compared. This statistical sin is common in the field of social statistics where comparisons relate primarily to the individual and where due allowances are not made for his peculiar and often transient reactions. It may even be common in the exact sciences. A search of your own experiences would probably reveal many glaring instances of its commission.

What is true today in our banking practices was not true five years ago. A bank rate which is justified today would have been condemned then, and vice versa.

In all research certain things should be avoided. I mention this fact not because it is new, but because, to me, it is fundamental. Avoid confusing a single cause with a combination of causes. This is not so much a statistical, as it is a logical injunction, but it must be observed nevertheless. Do not confuse the result of a single cause with a combination of causes. The person who expects, in industry, a single cause always to give rise to a single effect, or a single effect always to come from a single cause, is expecting more than will ever be realized. To look for a single cause for a single result, or a single result to arise from a single cause, is useless. Causes and effects do not operate in this fashion, and the person who forgets this fact in the interpretation of statistical data is bound sooner or later to be disappointed with the results. There is, for instance, no single cause for labor distrust, sabotage, or unrest, and there is no single result which follows from them.

Avoid identifying immediate and superficial with remote and fundamental causes. What are the "causes" of the high costs in our present methods of retail distribution? Some will seek them in the recent war, some in profiteering. Both may be immediate, but they are hardly fundamental. A more fundamental cause is the presence of small and poorly equipped merchants and their grossly unbusinesslike methods.

Another thing in the interpretation of data is necessary. Distinguish between drawing a particular deduction and giving it general application. This is an error into which most of us fall, and from which immunity comes at a high price. Data may unmistakably point to one conclusion, but this may hold only for the particular data used and not for data in general.

These are some of the "don'ts" in statistical analysis which are worth mentioning. Let me state them again in summary. Avoid confusing a single cause with a combination of cause. Avoid identifying immediate and superficial with remote and fundamental causes. Distinguish between drawing a particular deduction and assigning to it a general application. These cautions should be observed by all.

In summary I simply want to call attention briefly to a few points which I hope I have made, probably imperfectly, but at least I have attempted to make them. There is nothing peculiar about the job of the statistician except that he has a very difficult kind of material with which to work—somewhat more difficult, possibly than that with which the engineer is acquainted, because there are more disturbing elements controlling his units of measurement. The human factor comes in and it is difficult to measure. We no longer try to conjure up an "economic" man. He is dead. People are now classified according to their individuality and group traits—social psychology—in an attempt to understand and measure their reactions. The statistician's problems are different from those of the engineer because of these facts, but his method, at bottom, is the same. He is guided by one motive, that is to discover the truth. If he is true to himself and true to those whom he serves, he will be guided by the principles of scientific method, he will infer logically, and act courageously.

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TECHNICAL PAPERS

ACOUSTICAL PROPERTIES OF BUILDINGS

By F. R. Watson*

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INTRODUCTION.

The action of sound in a building is much of a mystery to many people. There is a popular belief that wires stretched in an auditorium will be of benefit for faulty acoustics, or, if this fails, that a sounding board over the speaker's head will remedy matters. Also, concerning sound proofing in buildings, an impression prevails that an effective wall is one containing air spaces. These popular conceptions are not altogether supported by the facts. People who regard the problem with a degree of seriousness realize that the action of sound is not a matter of chance, but that the phenomena must accord with scientific laws. It is the purpose of this paper to set forth some of the essential principles and practical applications that are already known, also to indicate the problems yet to be solved.

ACTION OF SOUND WAVES.

Sound consists of a series of pressure pulses that originate in a vibrating body and progress through the surrounding medium with a considerable velocity, v, depending on the elasticity, E, and density, d, according to the formula: $v=\sqrt{E/d}$. The following table gives velocities for a few common media.

Medium	Velocity of Sound in Feet per Second
Air	1088
Water	4700
Pine Wood	10900
Brick	11980
Steel	16360

The amplitude of vibration of the particles that propagate the sound waves in air is small, carying approximately from .00000005 inches for a sound barely audible to .04 inches for a loud sound. A very small motion of a building partition will therefore be sufficient to generate a sound in the air that may be detected by the ear.

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Rapid vibrations, such as those set up by motors, fans and machinery, give rise to continuous musical sounds that become annoying to many people. Other vibrations, due to street traffic and elevators, may be larger in amplitude than those mentioned but their frequency is small,—about 6 to 9 per second,—so that they do not affect the hearing as those of higher frequency do. A distinction should be made between the vibrations of the building structure and sound. Compressional waves (sound) may start from the vibrating member, but it should be realized that the two actions are not the same phenomenon.

When sound waves meet a new medium with a different elasticity or density, a reflection takes place in proportion to the change. For instance, sound waves in air impinging on a plaster wall of some rigidity will suffer a reflection of over 99 per cent, or conversely, sound traveling in a plaster wall on meeting an air boundary will be reflected in much the same proportion. On the other hand, sound progressing in a building structure of brick, wood and steel will not be affected as strongly, assuming an intimate contact of the different materials, because the changes in elasticity and density are smaller.

The preceding brief discussion of the fundamental phenomena of sound waves will make the action of sound in a building more easily understood.

SOUND PROOFING IN BUILDINGS.

The insulation of sound in a room is not an easy matter. Practical attempts to secure such sound proofing are not always attended with certainty of success, even when the constructions appear to be in accordance with theory and are patterned after other successful installations.

It is necessary to consider that there are two types of sound to be insulated. One type includes sounds of a violin, flute, the human voice, etc.,—sounds that are generated in the air and progress through the air to the boundaries of the room. If the walls are rigid and massive with no cracks or openings, these sounds are reflected almost completely and are thus confined easily to the room. Usually, however, openings of some sort are necessary, such as doors, windows, ventilation ducts, etc., so that the sound escapes through these air passages unless some special provision is set up to prevent it.

The other type of sound is due to vibrations in the building structure. For instance, an elevator in its progress will set up tremors in the supporting framework which are transmitted through connecting members to the surrounding walls. From here, these tremors proceed rapidly through the continuity of structure and may be converted into sound in the air by shaking a loose door, or transom, or by imparting a magnified motion to some partition or floor with which they happen to be in tune.

The construction of any successful type of sound-proofing must involve a consideration of the actions just described. That is, the insulation of sounds proceeding through the air requires the interposition of continuous walls, floor and ceiling of some rigidity. For vigorous sounds, such as those generated by an organ, the walls would need to be especially rigid and massive. It should be remembered, in this connection, that the amplitude of vibration of the partition may be very small and yet produce sound. Doors and windows should be closed tightly and ventilation ducts should be specially arranged to avoid transfer of sound.

Vibrations traveling in the building structure are more difficult to insulate than sounds in air. The installation of a medium that has different elasticity and density tends to reflect the vibrations. For instance, an air space in masonry will be a good insulator provided no solid material bridges over the air space. This is not practical in usual building conditions so that the construction is approximated by special

devices such as double partitions with air space containing a sound absorber, floors floated on felt or granulated work, etc.

EXPERIMENTAL DATA.

Systematic investigations of the acoustical action of partitions have been inaugurated.* The data thus obtained gives suggestive information concerning the construction of effective sound proof walls. Some definite results have been found, but much remains to be done. One such series of experiments has been conducted by the writer. The transmission of sound has been measured for partitions varying from thin porous hairfelt, flax board, building paper and plaster boards to solid plaster partitions of several inches thickness. The experiments were conducted in sound insulated rooms.

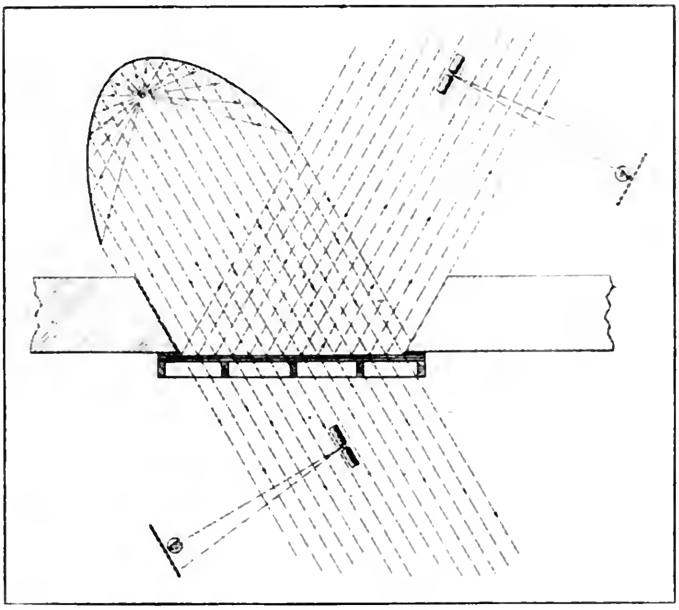


FIG. 1.—Diagram of Apparatus

A specially constructed organ pipe blown by constant air pressure was mounted at the focus of a parabolic reflector. The sound was thus directed in a parallel bundle against the partition under test. Part of the sound was reflected and the remainder either transmitted or absorbed in the material.

Since the measurements were to be comparative, all conditions were maintained as constant as possible so that the only changing factors were the partitions under test. Measurements were taken with a Rayleigh Resonator, an instrument consisting of a brass tube of special shape containing a delicately suspended disc that rotated under the action of sound and allowed calculations to be made for the sounds transmitted through the various partitions. For the thicker partitions, a resonator was used that was of the same order of sensitivity as the ear, therefore giving an acceptable instrumental substitute. The ear is not trustworthy in its estimation of sounds of different intensity.

The results of the investigation led to the following conclusions. A porous partition transmits sound quite easily and in proportion to its porosity. If the pores are extremely small, friction effects tend to damp out the energy. Solid, non-porous

*"Acoustics of Buildings" Handbook of Building Construction, published by the McGraw-Hill Co., 1921, p. 751.

partitions stop sound in proportion to their *inertia,* or mass. If the partition is fastened at the edges, as it must be in practical constructions, the incident sound pressure must overcome not only the inertia, but also the *rigidity* or the resistance to distortion. The character of the structure of the partition affects the transmission.

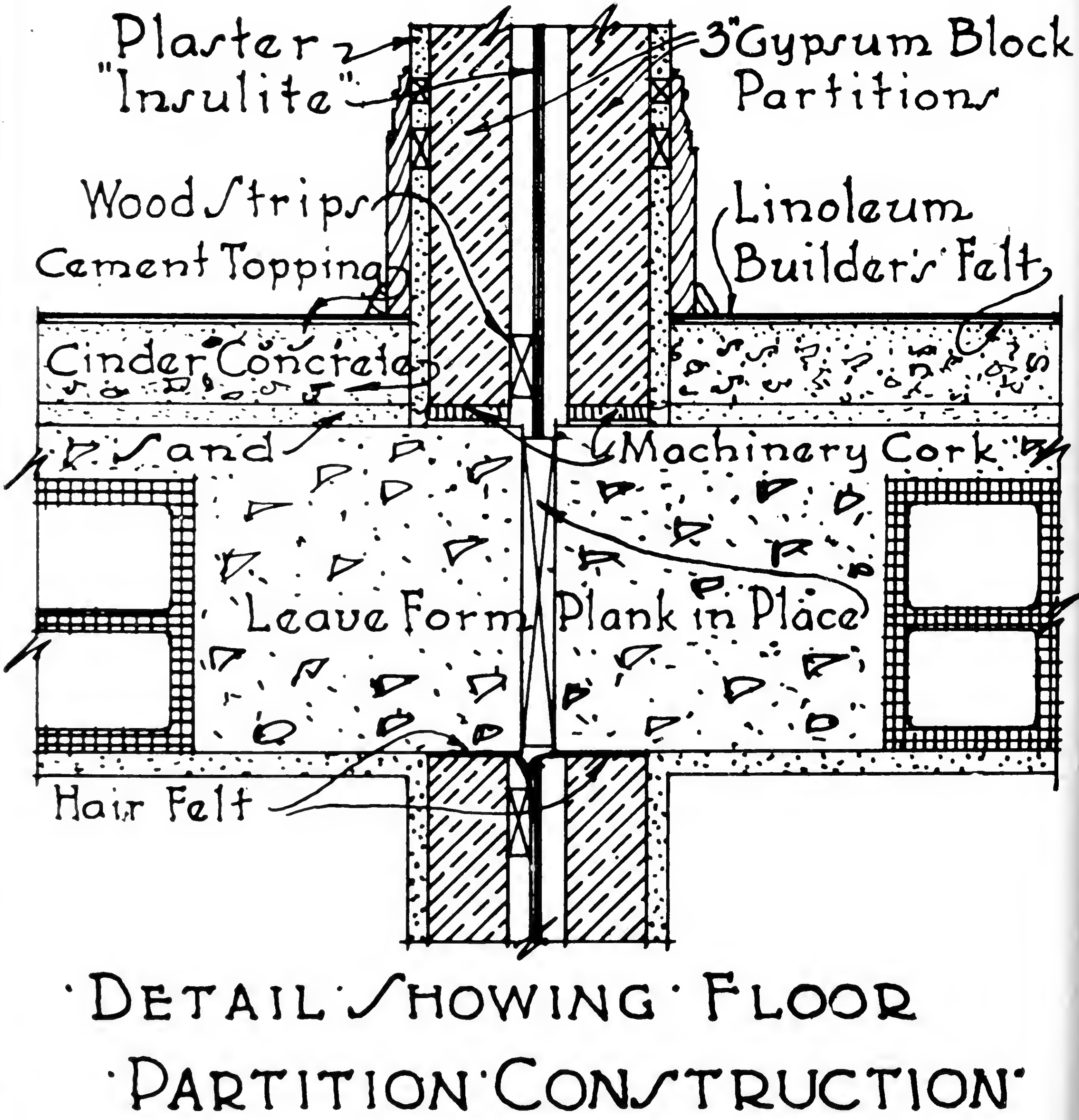


FIG. 2.—Detail Showing Floor and Partition Constructions.

Homogeneous partitions appear at an advantage over those made up in layers or in sections. Reinforced partitions are more rigid and hence more sound proof than partitions without such reinforcement. The transmission of sound depends also on the vibration of the partition. Sound waves acting on one side of a partition may set it in vibration so that its motion creates similar sound waves on the opposite side; that is, the energy is transmitted. A consideration of these effects shows that thick

walls are good sound insulators because they have the desirable qualities of mass, rigidity and are not easily vibrated.

Practical applications of sound proofing were tried in the Smith Music Building at the University of Illinois. In co-operation with the architect, Professor James M. White, the attempt was made to sound proof the entire building. This problem involved the sound insulation of some fifty small practice rooms, twelve studios, and the larger concert hall, besides the acoustic control of sounds of motors, fans and elevators. Double walls, floors, and ceilings were constructed in accordance with the descriptions set forth in the previous paragraph. Tight fitting doors and windows were specified to prevent leakage of sound and seperate ventilation ducts were designed to convey air to and from each room.

Fig. 2 pictures some of the features that were adopted to control sound. The concrete floor, 12″ in thickness, was broken in its continuity by the form planks that were purposely left in place. Walls between rooms were constructed of two 3″ gypsum partitions insulated at the bottom by machinery cork and at the top and sides by hairfelt. Insulite was installed in the air space between the gypsum partitions to absorb sound and also present a barrier in case cracks developed in the gypsum. The finish floors were floated on a 1″ layer of dry sand to break the continuity of material and thus stop the progress of vibrations.

Without dwelling on all the details it is perhaps sufficient to state that some degree of success attended the efforts. Students use adjacent rooms for piano practice, singing, violin and other instrumental drill, etc., without serious disturbance to each other. The rooms are not absolutely sound proof nor does this appear necessary because the sound that leaks into the room is so diminished in intensity that it is unnoticed when practice is in progress. The ventilators transmit sound between different parts of the building, but the use of separate pipes for each room diminishes the intensity of these transmitted sounds so that they become unimportant compared with sounds generated in the room itself. Four separate ventilation systems were installed to increase the sound insulation.

After several months of use, the building is considered satisfactory for the purpose. Absolute sound proofing cannot be attained without very unusual, and perhaps impractical, building constructions. It appears from the experience with the Music Building thus far that absolute sound proofing is not essential. There are many things yet to be learned by further experience, but enough has been revealed to give encouragement to the belief that sound-proofing may be prescribed in the near future with some of the certainty that now attends the acoustic design of auditoriums.

ACOUSTICS OF AUDITORIUMS.

The second large acoustical problem in buildings involves the proper design of auditoriums for speaking and music. This problem was solved in its essential details by the late Professor Wallace C. Sabine, of Harvard University. He showed that the time, t, taken for a sound of standard intensity to die out in a room depends directly on the volume, V, of the room and inversely on the sound absorbing power, a, of all the surfaces in the room exposed to the action of the sound; that is,

$$t = kV \div a,$$

where k is a constant depending on the intensity of generated sound.

Auditoriums with defective acoustics are usually too reverberant, that is, it takes the sound too long a time to die out. Words uttered in succession by a speaker overlap and confuse the auditors who find difficulty in following the sequence of the speech. This defect is not so marked for musical sounds because they may

overlap and yet by their mixture produce an effect that is usually pleasing. The correction for the defect lies in the introduction of sound absorbing material to reduce the time of reverberation. Experience shows that suitable values for the time vary from about 1.5 to 2.5 seconds, depending on the volume of the auditorium. Small rooms, such as offices, may be deadened much more than the auditoriums discussed.

Professor Sabine determined the absorption coefficients for a number of materials found in buildings. The following table gives some of these, unit area of each being considered.

Material.	Absorbing Coefficient
Open window space	1.000
Audience	.96
Hair felt, 1″ thick	.55
Heavy rugs	.25
Carpet	.15
Wood Sheathing	.061
Plaster on lath	.033
Plaster on tile	.025
Glass	.027

An inspection of these coefficients is instructive. Plaster, glass and wood are the materials usually employed in the construction of an auditorium, and these absorb little sound. Therefore, a reverberation is to be expected in a room of some volume unless additional absorbing material is introduced. The large absorbing power of an audience is an important factor in this respect. An auditorium with defective acoustics when empty may become quite satisfactory when a large audience is present; that is, the absorbing power of the audience reduces the time of reverberation to an acceptable value. In the acoustical correction of auditoriums, it is considered desirable to have conditions largely independent of the audience. Absorbing material such as felt, upholstered seats, etc., is prescribed to reduce the reverberation to a marked extent before the audience is considered.

By means of Sabine's formula and the table of absorption coefficients, calculations may be made giving the time of reverberation so that recommendations may be made for the acoustical features of an auditorium before it is built. The data needed can be obtained from the plans of the room.

The installation of sound absorbing material involves another question. Certain walls are likely to produce echoes and these should be padded to reduce their action. Therefore a study should be made showing how sound starting from the speaker's position will be reflected after one and two reflections. This inspection will reveal possibilities for echoes and indicate which walls should be treated with padding. An extensive study of this kind was made by the writer in connection with the Auditorium at the University of Illinois leading to its acoustical correction.* The investigation brought out the facts that wires strung in an auditorium, sounding boards and ventilation currents have practically no effect on the acoustics.

To locate possibility of echoes and objectionable reflections of sound from walls, photographs have been taken of miniature models of auditoriums showing the action of waves. A special apparatus was devised consisting of a tank with a glass bottom on which the outline model of the auditorium was laid. Water was then poured in the tank and waves were generated by a stream of compressed air which

*"Acoustics of Auditoriums," Bulletin No. 73, and "Correction of Echoes and Reverberations," Bulletin No. 87, University of Illinois Engineering Experiment Station.

was interrupted by passing through a circle of holes in a rotating disc so that puffs of air impinged periodically on the water surface. The waves were made visible by flashes of light passing up through the tank and forming a shadow of the waves on a frosted glass. If the flashes of light came a little less frequently than the waves, the shadows moved slowly. Motion pictures were taken of these shadow waves and information was thus gained by analogy concerning the action of sound waves. Fig. 3 pictures one phase of such waves.

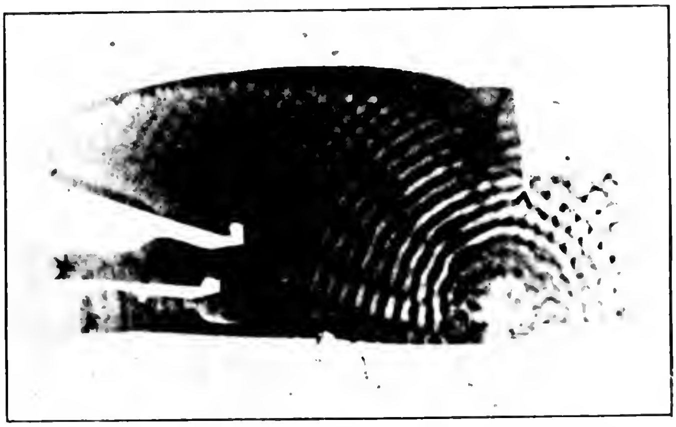


FIG. 3.—Photograph of Waves in an Auditorium.

CONCLUSION.

The discussion has shown that one important problem in the acoustics of buildings lies in the sound proofing of the various rooms. Considerable progress has been made on this problem, but much is left for further investigation. Additional information in this connection should be available before long from the constructions recommended for the Eastman School of Music at Rochester, New York. This school includes two concert halls besides practice rooms, studios and other essential features.

The acoustical correction of auditoriums is a problem attended with more certainty of success than the insulation of rooms. Further investigation should be made of the intensity of sound in various auditoriums, especially in those of large volume. There is also need for the development of sound absorbers that are efficient, fire proof, comparatively inexpensive and capable of being cleaned without impairing their acoustic efficiency.

While it is seen that a number of problems await solution, it is also apparent that a considerable fund of information is at hand for guidance in securing satisfactory acoustics, particularly in auditoriums. It would therefore seem desirable for architects and builders to avoid the acoustical defects so prevalent in existing buildings by specifying in advance of construction of new buildings that proper action be taken to secure satisfactory acoustics as far as possible.

THE CLASSIFICATION AND MAINTENANCE OF OLD RAILROAD BRIDGES

By C. F. Loweth,* M. W. S. E.

Presented March 17th, 1921.

This paper will present some of the problems pertaining to the determination of the strength of existing railroad bridges which for various reasons may be subject to conditions of service more severe than those for which they were designed. Notwithstanding that the title refers to bridges in general, the paper will be confined principally to the superstructure of bridges.

The maintenance of railroad bridges involves two general considerations: safety to carry traffic; and economy in obtaining the maximum life from the structure at reasonable maintenance cost.

The necessity for renewing bridges usually arises from physical deterioration, or overloading, or both. Physical deterioration usually limits the life of timber bridges, and occasionally that of metal bridges under certain conditions, such as structures over railroad tracks where corrosion is much more rapid than usual. Overloading comes about through the rapid increase in weight of cars and locomotives.

New bridges are designed for locomotive and car loadings somewhat in excess of those in existence at the time, and unit stresses are so proportioned to the ultimate strength of the materials that the structure will have a considerable margin of strength for future increase in loading and for the many exigencies which may arise in the life of the structure. However, the increase in the weight of locomotives and cars has been so rapid that on railroads older than about 20 or 25 years, there will be found some light capacity bridges incapable of carrying the traffic with the desired margin of safety. Such bridges must be replaced, or strengthened, or the weight of trains allowed to pass over them must be restricted. Any limitation of the weight of trains may very greatly affect the economical operation of the road if the traffic requirements demand and the condition of the property in other respects permit of heavier train loadings. On the C. M. & St. P. Ry. locomotive axle loadings have increased from about 22,000 pounds in 1875 to about 66,000 pounds at this time; car weights have correspondingly increased. For the greater part, the first crop of bridges have been long since retired, but there are a large number of bridges yet in service which were dsigned for much lighter loadings than are now in use. To what extent they can be continued in service, with or without strengthening, is a question for serious consideration. On a large railroad there are many such structures; they are of many vintages and located so as to be subject to widely varying conditions; so that it is necessary to consider each on its individual merits.

CLASSIFICATION OF BRIDGES.

The term classification of bridges is here used to describe the systematic investigation of old bridges with a view of determining the maximum loads which they can safely carry. In order to conduct a systematic investigation of the carrying capacity of bridges, it is necessary to adopt a standard measure. Most any assumed train load might be used for this purpose, but on account of the universal use of Cooper's Class E loading, the C. M. & St. P. Ry. Co. has adopted this loading as the standard unit of comparison and the capacity of all bridges on our line is expressed in terms of Cooper's E loading.

*Chief Engineer, C. M. & St. P. Ry., Chicago.

In order to obtain direct comparison between the structure and the power to be operated, it is, of course, necessary to obtain the effect of the various locomotives and train loadings in actual use, on the various members and details of each structure in terms of the standard used for rating the bridges.

The present practice on the C. M. & St. P. is to make an investigation or "Classification" of all bridges subject to loadings much in excess of those for which they were designed. The carrying capacity is determined in terms of the standard series of train loadings. New engine and car loadings that come up for consideration are classified in that same series of standard loadings, and it is then a matter of direct comparison to tell whether or not such proposed loadings can be handled safely over the various bridges.

UNIT STRESSES.

Classification is based upon maximum unit stresses which are considered proper for the various materials as used in the structure under consideration; these unit stresses are nearer the limit of useful strength of the material than in the case of new structures.

The maximum unit stresses permissible in old structures cannot be arbitrarily determined for universal application. There is perhaps no greater responsibility placed on a bridge engineer than in determining the safe rating of an old bridge; the work involves far more than the mere calculation of stresses and the arbitrary assumption of safe unit stresses. In order to intelligently decide upon the limiting unit stresses the following should be given full and careful consideration:

The design: Whether the details are well proportioned and direct in action, the degree of ambiguity or uncertainty as to distribution of stresses and of secondary stresses.

The character of workmanship and material entering into the structure as indicated by the reputation of the shops at which the bridge was built and the thoroughness of the inspection as disclosed by inspection reports of material and shop manufacture.

Deterioration and wear.

Action under load, such as rigidity and freedom from excessive vibration.

The speeds likely to obtain over the structure and confidence as to the observance of such speed restrictions as may be imposed.

The certainty as to the assumed loading being the maximum to which the bridge will be subjected.

Importance of the traffic and the hardship which might result from temporary disablement of the structure.

The reliability of the data upon which the investigation of the structure is based.

In general the exercise of good judgment and experience based upon all of the factors surrounding the bridge, its location, service and condition.

Coming now to unit stresses: Axial stresses in tension per square inch may generally be taken as follows:

	Wrought Iron	Steel
In flanges, beams and girders.....	20,000 lbs.	24,000 lbs.
In truss members...............	18,000 lbs.	22,000 lbs.

Stresses of other kinds should generally be proportional to these the same as in the design of new structures.

To the designer of new structures these unit stresses seem large; in the case of old bridges they frequently seem small, especially in the case of the structure subject within regular service to stresses of such intensity and at the same time indicating little or no evidences of distress.

There may be at times conditions which may require, and at the same time justify increasing the limiting axial tension stresses to a maximum of 22,000 pounds for wrought iron and 26,000 pounds for steel. It does not seem wise, however, to permit these higher stresses except in the case of structures which are to be removed or strengthened at an early date, or where the traffic over them is relatively unimportant. It sometimes happens that a bridge must be kept in service longer than would otherwise be necessary because of pending improvements such as double-tracking, revision of grades or alignment, etc., which delay its replacement. The higher unit stresses may be necessary to meet emergencies of this or other nature.

For timber structures, there is a similar necessity for exceding at times the unit stresses generally considered desirable for new structures. The relative increase, however, is not nearly as great as for metals. The factors which must be taken into account for such structures are similar to those for metal bridges, and it seems desirable to give special consideration to the age of the structure. Deterioration of timber bridges is much more rapid than that of metal structures. For this reason it seems desirable to make the limiting stresses decrease with the age of the structure, or the particular portion of the structure under consideration. As an illustration, if fir stringers for pile and trestle bridges can fairly be assumed as having a life of 12 years, and the unit stresses for new structures is taken at 1,200 pounds, it would seem reasonable, under proper restrictions, to permit of unit stresses up to 1,600 pounds for stringers in good condition not over six years in service, and to decrease this at say 100 pounds for each year of additional life.

It is desired to again call attention to the fact that the stresses mentioned are not to be applied indiscriminately. There may be cases where the limiting stresses should be less than those mentioned, and the writer has had cases in his own practice where the stresses have been even higher. It is obvious that the higher the stresses, the more care and discrimination necessary for intelligent and safe application. It must not be overlooked that increasing the loading with consequent increase in unit stresses will materially increase the vibrations of the structure and the wear and tear on the details of connections, will lower the margin of safety, with materially shorten the useful life of the structure, and will render it more liable to injury from the occasional things which may happen to it such as derailments, being struck by passing loads, excessive winds, etc. All such structures, therefore, demand a more thorough and frequent supervision than is necessary for structures which are not overloaded, so that any evidences of distress, misplacement, or injury from unusual causes will be promptly discovered and their importance as affecting the question of the continuation of the structure in service given proper consideration and attention.

There are some details of construction in which it appears that the limiting stresses might safely be increased at a larger ratio over the axial stresses heretofore indicated. This, for instance, is true of stresses on the flange rivets in plate girders, stringers and floor beams. The failure of a girder in the flange riveting could not take place before ample warning of distress would be evident in the way of loose rivets, in this case the riveting could be strengthened before further failure could occur. It is, however, very seldom that flange rivets show sign of overstress, in

fact. I am unable to recall a single instance where our bridge inspectors have reported loose flange rivets. This, of course, would indicate that the flange rivets provided in new designs are somewhat excessive. I see no reason, however, for changing the general practice in designing new girders on this account, since a few additional rivets in new structures do not increase the cost appreciably, whereas it is apt to involve considerable expense to strengthen the flange riveting in an old girder span under traffic.

IMPACT.

The impact for designing new bridges is taken as the maximum obtainable at unrestricted and very often at a very high speed, not usually obtained under ordinary conditions. In rating old bridges as to their maximum capacity, the impact allowance should be based on the probable maximum speed obtained. The speed is fre-

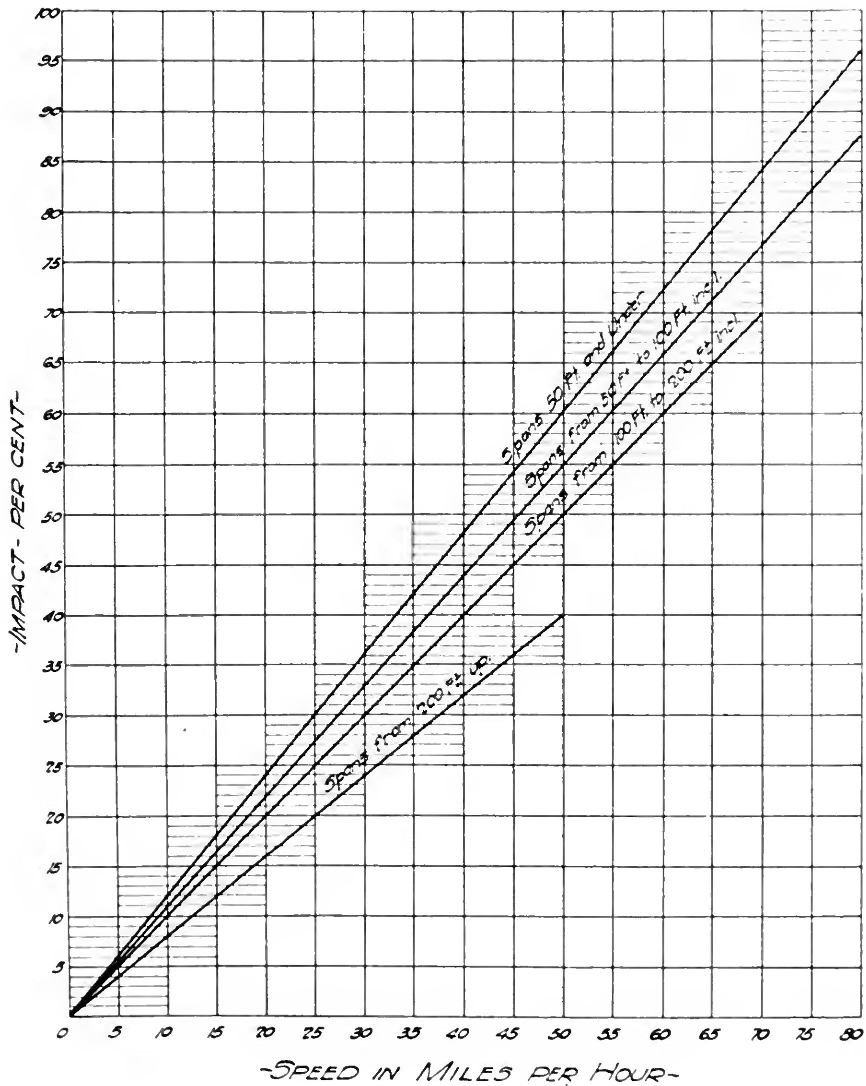
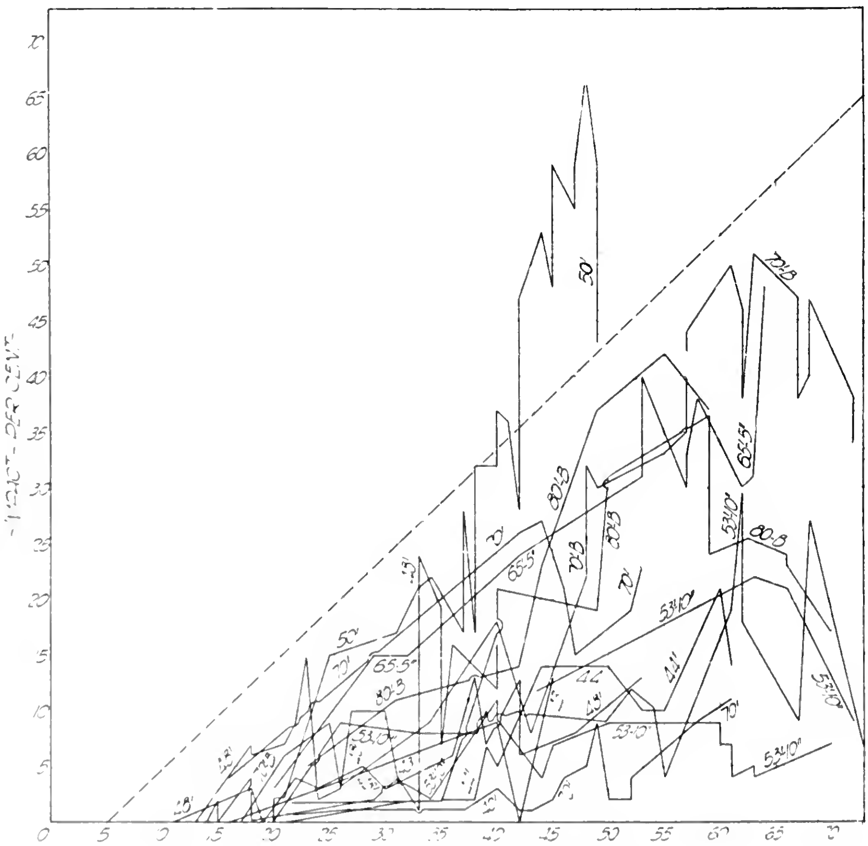


FIG. 1

quently known and it can be restricted arbitrarily or it may be restricted due to the conditions surrounding the location of the bridge or the character of the traffic. It is desirable, therefore, for the purpose of rating old bridges, to determine not the impact for maximum speeds, but for such restricted speeds as the structure may be

subject to, either by reason of arbitrary ruling or speed limitations brought about by the location of the structure as to proximity of stations, ruling gradients, etc.

The impact percent for various speeds and for spans of different lengths are shown in Fig. 1. The speed is laid off on the abscissa and the ordinate shows the percentage of impact to be added for various speeds for different span lengths. This diagram shows that if the speed is restricted to 20 miles per hour, the impact effect is about one-half of what it would be for a speed of 40 miles, or about one-third of that which would result if the speed was unrestricted. This impact diagram has been evolved from several diagrams upon which have been platted the results of the impact tests made by the A. R. E. A. classified as to speed of train and length of structures. Two of these diagrams are shown by Figs. 2 and 3.



-DECK PLATE GIRDERS- SPANS 43 FT TO 80 FT

FIG 2

Fig. 2 shows the impact observed for various speeds on deck plate girders from 43′ to 80′ in length. This diagram includes a total of 14 spans, all of which have open timber floors except three. The length of span is marked on each curve and the spans having ballast deck have been indicated by a B following the span length. Fig. 3 shows a similar diagram for 12 through plate girder spans, all with open ballast floor.

These diagrams indicate that for all practical purposes the impact is directly proportional to the speed. The similar diagrams for truss spans show a similar condition and on the basis of this practical information, the curves were drawn to cover the probable maximum impact for various speeds and different span lengths represented by the curves.

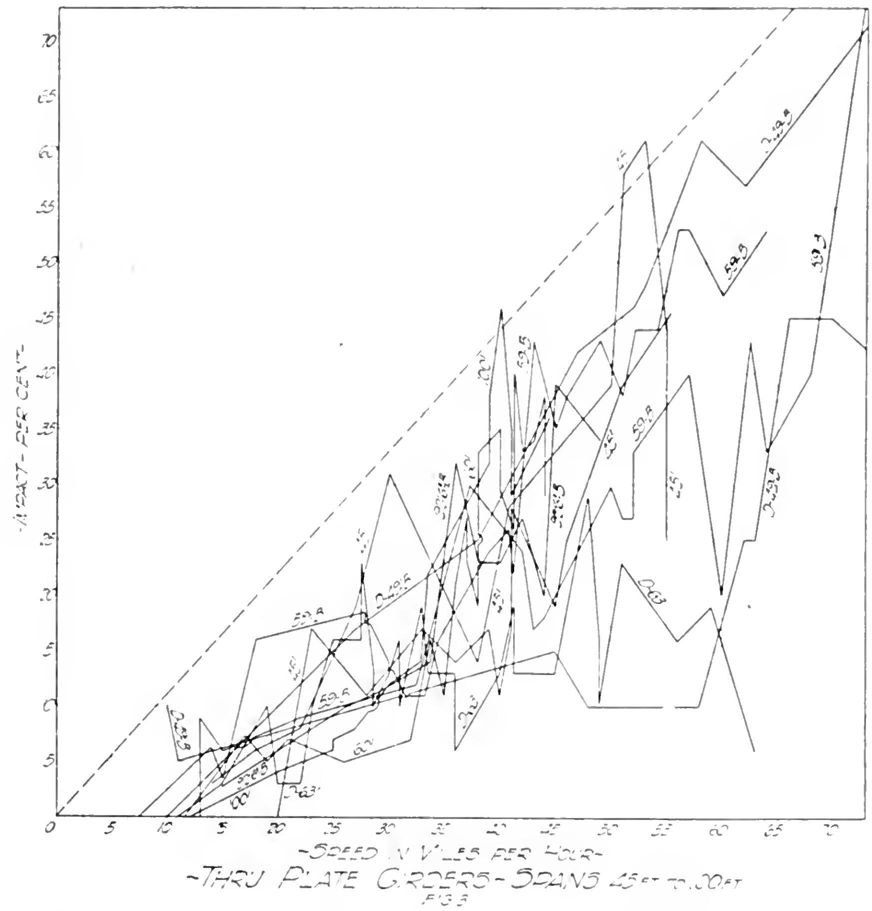
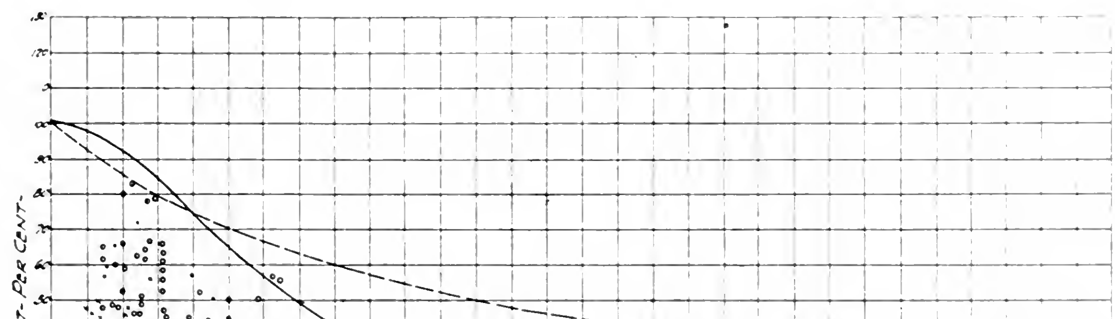


Fig. 4 shows curves of maximum impacts for various span lengths. The lower curve is that obtained from plotting the impact formula $\frac{300}{300+\frac{L^2}{100}}$ contained in the specifications for steel railroad bridges recently adopted by the American Railway Engineering Association. The upper curve is the one obtained by plotting the impact formula $\frac{300}{L+300}$, L denoting the loaded span length. It will be noted that



for span lengths above 100′, the later formula gives values below the values obtained from the earlier formula. For span lengths below 100′ the values are slightly above that obtained by the earlier formula. This diagram is inserted as a matter of comparison between the impact obtained from the usual speed of trains and that obtained from the maximum speed, and it will be noted that for a 50′ span, the maximum impact percentage is approximately 93, while for the same span length the impact for a speed of 60 miles per hour does not exceed 72%.

This difference in percentage of impact has considerable influence on the rating of a bridge, and represents one of the factors of which we may avail ourselves without really cutting down the factor of safety as originally intended.

GENERAL METHODS.

In general the investigation for any part of a bridge would be as follows:

1. The maximum allowable stress is determined which, in the simpler cases, is the cross sectional area of the member times the limiting unit stress allowed.

2. Deduct from this the stress due to "dead load" and "wind load." The remainder gives the allowable stress for the "live load" effect.

3. Divide this by the stress for unit "live load" (Class E-1) which gives the classification for allowed "live load," if at rest.

4. Divide this classification by the term which takes into account the extra effects of the "live load," due to impact and centrifugal force, the result being the classification of the allowed "live load" at full speed.

As an illustration of this general method, let us consider the example of the hip vertical member shown as U1-L1 of a truss having 25 ft. panels. Assume that this consists of two steel bars, 4 in. wide by 1 in. thick, giving 8 sq. in. of cross section. If we assume that in this case the circumstances warrant the limiting unit stress of 24,000 lbs. per sq. in., the total allowed stress is 192,000 lbs. Assume that the dead load stress is 17,000 lbs. and that the windload is so small that it may be neglected. The total allowed stress available for live load is then 192,000 lbs. — 17,000 lbs. = 175,000 lbs. The stress in the member for the Class E-1 loading as determined by the usual methods of computing stresses in bridges, is 1890 lbs. The total allowed live load classification, it at rest, is therefore $\frac{175,000}{1890} = 92.6$. Impact if taken by the ordinary formula is $\frac{300}{300+50} = .857$ of the live load. Considering the bridge on straight track, the centrifugal force stress is zero. Therefore, if LL represents

$$LL + .857LL = E\ 92.6$$

the net live load at full speed $LL = \frac{E - 92.6}{1.857} = E\ 49.9$ which represents the "Classification" of the member at the assumed unit stress. That is: An engine with wheels spaced as in the Cooper loading, having 49,900 lbs. on the driving axles, and the other axle loads in proportion, will produce the assumed stress of 24,000 lbs. per sq. in. if taken in connection with the other forces which are assumed to be acting.

CLASSIFICATION OF LOADINGS.

Locomotive loadings are of almost infinite variety and any standard loading would in most cases be different from the actual locomotive axle loads and spacing for the particular locomotives desired to be operated over the structure under investigation. In expectation that the margin of strength will be reduced, it is obvious that if the actual conditions which are likely to obtain in the structure are to be

known, that the investigation should be for the actual loading to which the structure will be subjected. A criterion for comparative purposes is desirable and this is taken as the well known Cooper's Standard Class E Loadings. By computing the maximum bending moment and end shears for the actual loading and dividing these with those resulting from the standard Class E-1 loading, the equivalent standard loading for the particular length and kind of span under consideration is found.

It is surprising to observe the extent to which it is generally assumed that the effect of various train loadings on bridges is in direct proportion to the aggregate weight of the locomotives and cars. This, of course, is far from the truth and no approximation by such a method should be used to determine the safety of any bridge.

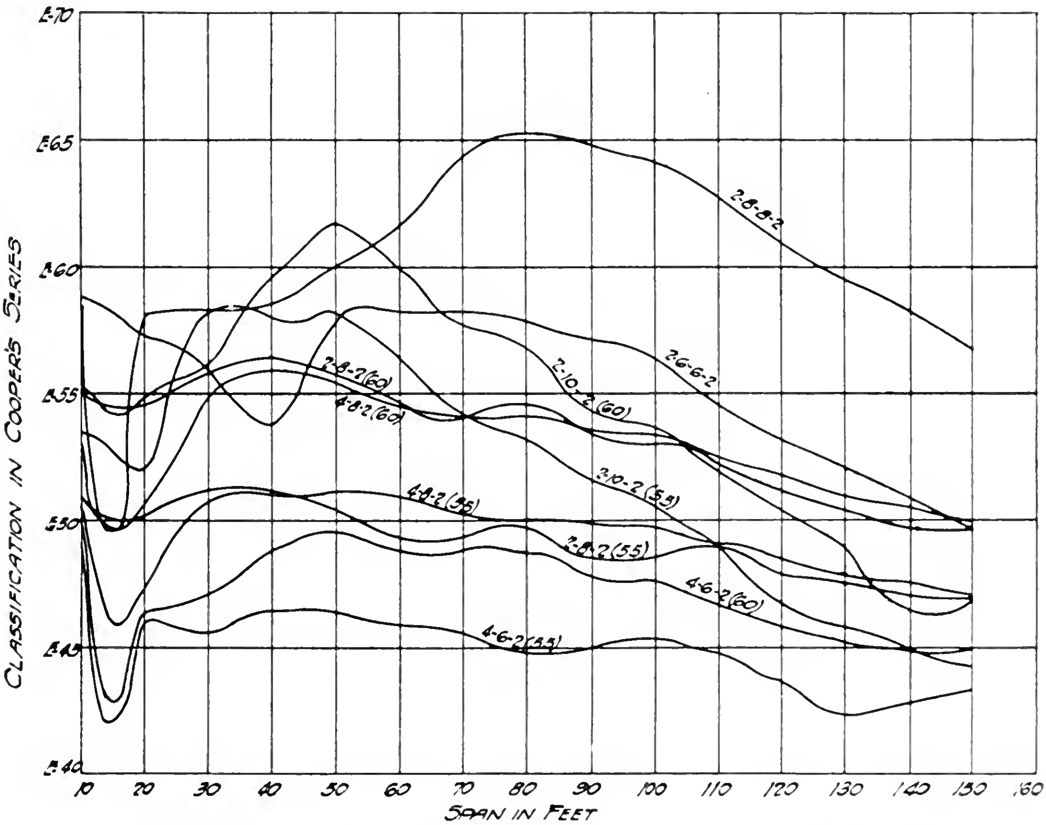


Diagram Showing Classification of Locomotives Listed in Table I
For Maximum Bending Moments on Various Spans
Diagrams for 2 Engines (Except Santa Fe and Mallet types) followed by Trainload of 5000 lbs. per lin. ft.

Fig. 5

Figure 5 shows the classification of several types of U. S. Railroad Administration Standard locomotives for various span lengths compared with the standard Cooper Class E Loading. The diagram shows for each of the locomotives the relation between the effect of the given engines on bridges as compared with the Standard Cooper's loadings which are used as a basis for the classification of bridges. The divergence of the several curves from the horizontal shows the differences of the effects of these loadings on the different spans, as compared with the effect of the Cooper loading, which is represented by a horizontal line for each class. The locomotives classified in Fig. 4 are those listed in the following table:

Type.	Service.	WEIGHT On Driver Axle	Total Engine	Engine & Tender	WHEEL BASE Driving	Engine	Engine & Tender
Pacific (4-6-2),	Passenger	55,000	270,000	414,000	13′-0″	34′-9″	67′-6½″
Pacific,	Passenger	60,000	300,000	444,000	14′-0″	36′-2″	70′-8½″
Mountain (4-8-2),	Passenger	55,000	320,000	492,000	18′-3″	40′-0″	75′-8½″
Mountain,	Passenger	60,000	350,000	522,000	18′-3″	40′-0″	75′-8½″
Mikado (2-8-2),	Freight	55,000	290,000	466,000	16′-9″	36′-1″	71′-5½″
Mikado,	Freight	60,000	325,000	497,000	16′-9″	36′-1″	71′-9½″
Santa Fe (2-10-2),	Freight	55,000	360,000	532,000	21′-0″	40′-4″	76′-0½″
Santa Fe,	Freight	60,000	390,000	596,000	22′-4″	42′-2″	82′-10½″
Mallet (2-6-6-2),	Freight	60,000	440,000	646,000	10′-4″	50′-2″	88′-10″
Mallet (2-8-8-2),	Freight	60,000	540,000	746,000	15′-5″	57′-4″	93′-3″

POINTS OF LOW CLASSIFICATION

In old structures, it is generally found that the floor systems are comparatively lighter than the girders in plate girder bridges and chord members of truss bridges. The point of low classification in stringer floor beam and plate girder flanges is generally found at the point of maximum moment, except that where cover plates are used the low classification in the flanges may be found at a point where a cover plate terminates. The flange riveting near the ends of these members very often falls below that required by modern practice. The webs at the point of maximum shear and web splices near the ends of plate girders and the connection of floor beams to the gusset plates, frequently requires strengthening in order to produce a structure of uniform strength.

Members of low classification in truss bridges may be looked for in posts and diagonals near the center. The hip verticals very often are out of proportion to other members of the bridge. The end posts and top chords generally show up poorly on account of eccentricity with respect to pins. If the pins of a truss bridge are calculated according to the accepted practice for designing truss pins, they will nearly always show an extremely low rating.

In addition to the weak points in the design, the top flanges of stringers, deck girders and floor beams very often suffer from corrosion due to brine dripping and in bridges where the ties are supported on shelves, the shelf angles frequently are considerably weakened from corrosion. Overhead bridges are subject to excessive corrosion due to smoke and gases and this condition is further aggravated where these structures are covered with a solid floor which prevents the smoke and gases from escaping and also prevents the steel from drying out quickly; in cases of scant clearance, metal bridges may show excessive deterioration from sand-blasting effects of cinders. This is especially the case where overhead bridges are located on an ascending gradient.

STRENGTHENING OF LIGHT BRIDGES.

The method of strengthening light bridges depends on the type of structure and the nature and purpose of the reinforcing. The strengthening may consist of reinforcing minor details in order to obtain a well balanced structure, or the object may be to strengthen the bridge as a whole to materially increase its carrying capacity.

Girder, stringer and floor beam flanges may be strengthened by additional cover plates; or in case of girders, the classification may often be increased by splicing the web so that it will carry its portion of the bending moment. In cases where there are more than two lines of stringers and where they are not so spaced that each

stringer carries an equal amount of load, the stringers may be re-arranged so that the load is properly distributed or stringers of either timber or steel may be added; cross frames may often be used to equalize the load between the stringers.

The bending on the floor beams may at times be reduced by moving the stringers closer to the girders or trusses. Deck girders may be doubled up at a small expense; or three girders may be used; or, if conditions permit, the span may be supported by timber bents at the center.

Where the classifications of the riveting is low, additional rivets may be added or the rivets may be replaced with rivets of larger diameter. To replace a shop driven rivet with a larger field driven rivet may in some cases be of doubtful value, but where the original rivets were drawn in the field, this method may be resorted to.

Girder webs amy be strengthened by additional stiffeners at points of maximum shear, to prevent the web from buckling; web splices may be strengthened by additional rivets and in cases where the old splice plates will not permit of additional rivets, new and wider plates are added with an additional row of rivets on each side of the splice.

The strength of shelf angle construction may be increased by adding stiffeners at short intervals to support the outstanding leg of the shelf angle.

Diagonals in truss bridges may be reinforced with additional bars or loop rods. This scheme may also be applied to bottom chord members, and if necessary the rods may be connected to yokes bearing on the present I-bar heads. In cases where the load is eccentrically applied to end posts and top chords, these members may be materially strengthened by adding plates or angles so as to reduce or entirely eliminate the eccentricity and at the same time increase the area of these members. The moment in truss pins may be reduced by repacking the I-bars, by transferring part of the load to diaphragms placed inside a built-up member, or the pins may be replaced with pins of high carbon or nickel steel of the same size as the old pins. In extreme cases larger pins may be substituted.

With the maintenance of old bridges, the question arises whether it is more economical to strengthen the structure than to renew it. This to a great extent, depends on whether the old structure can be used to advantage on a branch line or is relegated to the scrap pile. On most large railroads there are branch lines carrying lighter traffic and requiring much lighter locomotives than on main lines; this condition makes it possible to remove bridges too light for main lines and use them on branch lines. Frequently the bridge will be quite suitable for branch line service without strengthening, although it will at times be found desirable to strengthen the bridge before it is re-erected in its new location, and this can be more economically done than while in service. Bridges which are too light for branch line service or which for other reasons cannot be so disposed of, can frequently be used in highway overhead structures.

As a general proposition, the yearly amount of money that it would be permissible to spend for strengthening would be equal to the interest on the investment in a new bridge less the cost of additional maintenance required by the old bridge on account of the greater attention it receives.

For illustration, consider a few lengths of through spans designed for E-55 loading, replacing similar spans designed in the early '90's, new steel work being

taken at 5c per pound erected, falsework at $10.00 per lin. ft., removal of the old structure at $10.00 per ton, salvage on old spans at 2½c per pound, additional cost of maintenance of the old span on account of additional inspection, classification and supervision required, $1.00 per ft. of span per year. The last column of the following table shows the amount which we could afford to spend per year in strengthening old spans rather than to renew them. The costs shown in this table are for illustration only. As they fluctuate from time to time the resulting economies will vary accordingly.

Span	Weight Pounds	Cost Erected	Salvage	Net Cost	Interest on Net Cost at 5 per cent.	Available for Strengthening Each Year
50′	66,000	$ 4,330	$ 1,130	$ 3,200	$ 160.00	$ 110.00
100′	218,000	13,390	3,700	9,600	480.00	380.00
200′	800,000	46,800	12,500	34,300	1,715.00	1,515.00
300′	1,600,000	92,200	25,000	67,200	3,360.00	3,060.00

The writer has in mind a bridge having three 400 ft. spans, which, if renewed about ten years ago, as some railroad managements might have done, would have cost about $370,000, after deducting the salvage value of the old spans recovered. The interest on this investment for the ten years would have amounted to about $185,000. Instead, however, of replacing these spans they have been carefully maintained and inspected and the details strengthened wherever the classification showed that it was necessary to carry the heavier traffic. The actual cost of strengtehning together with the additional maintenance expense has amounted to not over $20,000 during this period, showing a saving for this one bridge of about $165,000 because of the policy of getting the longest practicable life out of the structure.

This illustration shows but one way in which the problem may be considered. With old and light bridges a limit is reached beyond which it is not economical to strengthen them ,and replacement then becomes necessary. It must be recognized, of course, that a newly designed and heavy structure is prefrable to a lighter one. It is possibly true that in case of a train accident on a bridge, a lighter structure might be destroyed while a heavy new structure might withstand the same treatment without being seriously disabled. Such considerations must be taken into account in shaping the general policy of keeping lighter bridges in service.

Acknowledgement is made of valuable assistance in the preparation of this paper by Mr. H. J. Hansen, M. Am. Soc. C. E., Office Engineer, C. M. & St. P. Ry. Co.

LIGHTS AND SHADOWS OF THE ACTIVATED SLUDGE PROCESS FOR THE TREATMENT OF SEWAGE AND INDUSTRIAL WASTES

By Harrison P. Eddy*

Presented March 21st, 1921.

It is the object of this paper to touch briefly upon a few of the most interesting features of the activated sludge process and to point out the facts which have been rather thoroughly demonstrated and of which we are comparatively certain, and to indicate those which are still in doubt and upon which more investigational work and experience are required to determine the natural laws which govern and to perfect methods of procedure. In venturing to classify certain conditions as *established facts,* it is recognized that the process as a whole is still in the experimental state, that there are many conditions under which it has not been tested, and that circumstances may exist under which those features which we now feel are clearly understood will present unexpected difficulties and uncertainties.

DESCRIPTION OF ACTIVATED SLUDGE PROCESS.

For the benefit of those who have not given particular study to this process, it may be well to state briefly, in a general way, what it is and what it is capable of accomplishing.

When sewage containing a suitable supply of dissolved oxygen is agitated for a sufficient length of time, the fine suspended matter and the colloidal substances here gather into small aggregations called flocculi or floc.* When the sewage thus coagulated is permitted to stand quiescent, this floc quickly settles and forms at the bottom of the basin a very thin mud or sludge. The sludge is then withdrawn, and normally contains about 98% water. If such sludge be introduced into sewage, the rapidity with which the suspended and colloidal matters are coagulated may be greatly increased.

Thus the process as ordinarily carried out consists of adding sludge to the sewage, in proper proportion—roughly 1 to 5—introducing sufficient air to provide enough dissolved oxygen to maintain aerobic conditions, and agitating the mixture until practically all of the fine suspended and colloidal matter has been flocculated or absorbed by the floc introduced into the sewage. The mixture is then conducted to settling basins where the floc is removed by sedimentation and the clear supernatent water passes away as effluent. That portion of the sludge which is not required for the treatment of incoming sewage is diverted to sludge lagoons or it may be conveyed to a dewatering and drying plant where it can be converted into material suitable for use as a fertilizer base.

By this treatment sewage and many industrial wastes can generally be clarified and purified to a marked extent.

THEORY OF PURIFICATION.

The first and perhaps most noticeable function of this process is that of coagulating or flocculating the suspended and colloidal matters in the sewage. This action is similar in effect to the well-known chemical coagulation with sulphate of alumina or sulphate of iron and lime, and the floc resembles the chemical coagulum, particularly the ferric hydrate from the sulphate of iron and lime treatment.

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*The word "floc" as used herein, signifies a single sponge-like mass or an aggregation of such masses.

The floc is a sponge-like mass or an open-mesh network† which in the process of formation may envelop, entrap or entrain colloidal matter and bacteria. The sponge-like structure of the floc offers a very large surface area for contact, and this floc appears to be able to absorb colloidal matter, gases and coloring compounds. When the floc is driven about in the liquid it has a sweeping action* by which the colloidal substances may be said to be swept out of the water, or as stated by Philip Morley Parker‡ the "process may be regarded as passing a filter through the water in place of passing the water through a filter." Thus far the process appears to be primarily of a physical nature. It has been demonstrated, however,§ that it cannot be carried out under sterile conditions.

Just what the action of bacteria and other organisms may be, is a subject which should receive further investigation. One plausible theory is that the bacteria which are contained in the cell-like structure of the floc, feed upon the very finely divided matter and thus relieve the floc of its burden of such substances and restore its faculty of absorption to such an extent that when introduced into the incoming sewage the floc efficiently performs its function of absorbing the colloidal matter which will again be consumed by the living organisms which thus cause its regeneration. Because of these properties the sludge has come to be called "activated sludge," a term suggested by Ardern & Lockett.*

One of the cardinal principles of this method of treatment is that there must be dissolved in the sewage an ample supply of oxygen to maintain aerobic conditions. The action of the organisms in consuming the colloidal matter is one of digestion or oxidation—sometimes referred to as "moist combustion." Through this action the actual weight of suspended and colloidal matter is reduced, the products of the combustion being carried off in the form of dissolved or gaseous matter. This process, under favorable conditions, may extend to nitrification, by which substantial quantities of nitrates and nitrites are formed. Nitrification, however, is not necessary to the maintenance of sludge activity ,as seems to have been the opinion at the outset.

EXTENT OF PURIFICATION ACCOMPLISHED.

One of the bright spots in the experience with activated sludge is its high efficiency as a process of sewage purification. This much at least may be said to be well established. At Houston, Texas, it is stated by City Engineer McVea, that "fish have lived in the outlet chamber (effluent) for more than a year."*

So large a portion of the suspended solids and colloids may be removed that under ordinary conditions the effluent will be clear and contain but very little suspended matter; from 5 to 20 p. p. m., as a rule.

The sweeping process by which the colloids are absorbed, or coagulated, is also effective in reducing bacteria,—not by destroying them but by physically removing them.

In many cases color may also be removed, probably by action similar to that of mordants.

In the case of odors, some may be oxidized directly and some absorbed, the

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†Stein "Water Purification Plants and Their Operations," p. 143.
*Wm. R. Copeland, 2nd An. Rept. Milwaukee Sew. Comn., Dec. 31, 1915, p. 115.
‡"The Control of Water," page 556.
§Ardern and Lockett, Jour. Soc. Chem. Ind., Vol. xxxiii, p. 535, "Oxidation of Sewage Without Filters."
*Jour. Soc. Chem. Ind. Vol. xxxiii, page 524.
*Eng. News-Rec., Vol. 85 (1920), p. 1128.

resulting effluent being comparatively free from odors noticeable to the ordinary observer.

Oxidation of organic matter in solution occurs coinicdentally with the flocculation, and there may be nitrification where the treatment is fairly complete. In the latter case the treated sewage may be charged with a substantial quantity of available oxygen in the form of nitrates and nitrites, which will serve as a factor of safety against future putrefaction.

An interesting characteristic of this process is its adaptability to partial treatment. If the removal of colloids and bacteria and the production of a moderate degree of stability be sufficient, the process can be stopped short of material oxidation of organic matter and nitrification. On the other hand, if complete stability and oxidation of a substantial portion of the dissolved organic matter are required, the process can be so operated as to accomplish this, at least in many cases. As early as 1917, Mr. T. Chalkley Hatton, Chief Engineer of the Milwaukee Sewerage Commission, determined upon the following standard as a measure and limit of purification to be effected by the activated sludge process at Milwaukee:*

Reduction of bacteria	90%
Reduction of suspended solids	95%
Stability by Methylene blue	72 hours

Prolonged tests with the strong sewage containing a substantial proportion of industrial wastes have demonstrated that it is entirely practicable to meet this standard at Milwaukee.

While it may be proper at the present stage of development.to assume that in general purification may be carried to almost any extent desired, it is important to consider carefully the character of the sewage or wastes to be treated for there may be disturbing influences similar to those which appear to have been important at Worcester. There—probably because of the acid iron wastes from the wire mills—the extent of purification was decidedly limited, notwithstanding the use of very large quantities of air, a goodly period of aeration and re-aeration of the sludge.

The late Matthew Gault† concluded that Wormester sewage is apparently of such a character that nitrification does not take place readily and that it would be practically impossible to operate so as to constantly obtain uniformly good results. It may be noted, also, that nitrification does not readily take place when this sewage is treated by intermittent filtration.

AERATION.

The aeration feature which has been more generally studied than any other portion of the process, as at Milwaukee, Cleveland, Worcester, and Packingtown, and Stockyards in Chicago, and elsewhere, apparently is comparatively well understood.

Air is utilized for two purposes—for maintaining aerobic biological conditions and for agitation. Agitation, however, may be accomplished by other means, such as purely mechanical devices.

The oxygen requirements for the support of aerobic conditions are relatively small. Crawford and Bartow‡ found that only about 5% of the oxygen of the

*Eng. News-Rec. Vol. 79, p. 842.
†Rept. upon Experimental Treatment of Sewage by Activated Sludge Process, 1919.
‡F. M. Crawford and Edward Bartow, J. Ind. & Chem. Ind., Vol. 8, p. 646 (1916).

air used for aeration, appeared to be utilized, basing their conclusions upon analyses of the air entering and the gases escaping the aeration tank. The writer found only 10% of the oxygen disappearing in the case of strong tannery wastes. If the oxygen supply is to be obtained from air blown into the sewage, there must be sufficient opportunity for the sewage to dissolve out the oxygen while the air is passing through it.

The quantity of air required for agitation is very large. It is necessary to provide sufficient agitation to prevent the heavy suspended solids from settling down on to air diffuser plates and thus clogging them. Removal of suspended matter by fine screening, is a substantial aid in preventing such trouble. Even sewage which has passed a fine screen having openings 1/8-inch by 2-inch, may contain sufficient solids of this character to cause clogging of plates if the air supply be permitted to fall much below 1 cu. ft. per minute per square foot of plate area. By finer screening it might be possible to reduce this quantity slightly. Whatever be the character of the sewage the volume of air used must be sufficient to prevent any accumulation of solids upon the diffuser plates.

The volume of air required for aeration is mainly dependent upon the following general conditions:

Composition of sewage to be treated,
Quality of effluent desired,
Period of aeration,
Proportion of sludge to be returned to the sewage,
Temperature of aeration.

COMPOSITION OF THE SEWAGE.

The composition of the sewage has a very material effect upon the volume of air required to maintain aerobic conditions and to provide suitable aeration. A strong sewage, or industrial waste, requires more air than a weak one, not because of the direct action of the oxygen on the organic matter, but because there is a greater quantity of colloidal matter to be absorbed by the coagulum and in some cases also because of the larger quantity of dissolved organic matter to be oxidized. The larger the quantity of colloidal matter the greater must be the effective absorbing surface. This may be afforded by increasing the proportion of floc in the liquid, or by increasing the period during which the flocculation is continued. If the volume of return sludge be increased, bacterial digestion will be greater and consequently the quantity of dissolved oxygen must be larger in order to maintain aerobic conditions. Furthermore, the digestion of the absorbed colloidal matter and the reactivation of the sludge wil require more intense and more prolonged bacterial action in the case of the stronger liquid, thus requiring a greater supply of oxygen for biological purposes.

It may therefore be necessary, with the stronger sewage, to prolong the period of aeration. Such a course naturally increases the quantity of air required for oxidation.

For these reasons and many others, it is important to consider the composition of the sewage to be treated. In addition to the strength of sewage, it is necessary to consider the effect of particular characteristics, such as turbidity, the nature of the organic matter—whether relatively stable or easily decomposed,—and the effect of chemicals from industrial wastes, such as acids and alkalis. A relatively fresh

sewage may be low in turbidity and therefore comparatively easily coagulated and oxidized. On the other hand, certain industrial wastes such as those from stock-yards and tanneries, may contain such large quantities of colloidal matter as to require prolonged treatment for their removal. Some industrial wastes such as the pickling liquors from the wire mills, at Worcester, Mass., tend to inhibit bacterial action and thus increase the required period of aeration or volume of air, or both. It is necessary also, as found by Mr. Fuller* that a sufficient quantity of floc-forming material be present in the wastes. Otherwise such matter must be added in order to secure the desired result.

THE QUALITY OF EFFLUENT.

The quality of effluent to be produced has an important bearing upon the quantity of air required. In the case of domestic sewage and some industrial wastes it is possible to secure clarification with a lower expenditure of air than would be required to produce a stable effluent. On the other hand, with some industrial wastes high in turbidity, it may be impossible to secure clarification without at the same time producing a practically stable effluent. The extent of oxidation will, however, increase, with increasing volume of air used. It has also been demonstrated that the aeration process must be carried far enough to secure reasonably good clarification in order to produce a sludge of such character and density as to permit satisfactory sedimentation ,handling and dewatering. Otherwise the operation of the plant will be difficult, if not impractical. Within the limitations suggested, it is feasible to limit the degree of purification and consequently the quantity of air required, in accordance with the quality of the effluent to be produced.

PERIOD OF AERATION.

The period of aeration has been found to be a very important factor in the quantity of air required. Within limits, the volume of air will decrease with increasing period of aeration. Comparative tests have indicated that with a period of 8 hours only about one-half as much air is required as with a period of 4 hours. With the longer period of aeration, however, the rate of air supplied must be sufficient to maintain proper agitation and prevent the deposition of solids upon the air diffusers, as already pointed out. Where the sewage or wastes contain an abnormally large quantity of colloids, it may be absolutely necessary to provide a long period, such as 8, 12, or even 20 hours aeration in order to remove the colloids and produce an effluent having a moderately high stability. If an unnecessarily large proportion of sludge be returned, or if the period of aeration be unnecessarily prolonged, excessive quantities of air will have to be provided.

TEMPERATURE.

Temperature has an important influence upon aeration. Very high or very low temperature of the sewage is detrimental. The unfavorable effect of low temperature has ben repeatedly demonstrated. This effect may be in a measure, although probably not entirely, offset by increasing the volume of air. Fortunately in many cases the stream requirements are less exacting during cold weather than at other seasons of the year, and consequently it may be permissible in some cases to discharge a somewhat inferior effluent during the winter, and thus avoid the necessity of increasing the air supply.

For ready estimation of the quantity of air which will be required for biological

*Munic. & County Engr. Vol. lvii (1918) p. 123.

action and for agitation, more data are needed tha nare now available. While the strength of sewage has a very important bearing, a comparison of the results of analyses with the quaintity of air used at the several activated sludge plants, with a view to demonstrating this relation, is very disappointing. This is because of differences in methods of chemical analysis, lack of important determinations in some cases, differences in methods of operation, and many other dissimilar details. There are so many of these unharmonious features that it is only by a detailed study of each case, and a comparison of the conditions with those of the project under consideration, and the exercise of judgment, that it is possible to arrive at a safe estimate.

As a general statement where the aeration is carried out in continuous flow tanks of 10 to 15 ft. depth, with area of diffuser plates in proportion of 1 to 6, of tank area and a period of aeration of about 6 hours, the quantity of air may be about as follows:

For rather weak domestic sewage....................1.0 cu. ft. per gal.
For strong municipal sewage containing some industrial wastes not particularly detrimental to bacterial life..1.5 cu ft. per gal.
For weak municipal sewage containing considerable industrial wastes some of which are detrimental to bacterial life, as for example acid-iron wastes......2.0 cu. ft. per gal.
For strong municipal sewage containing considerable industrial wastes some of which are detrimental to bacterial life, as for example, acid-iron wastes........4.0 cu. ft. per gal.
For municipal sewage containing sufficient industrial wastes not specifically inhibitive of bacterial life, to decidedly influence the composition of the sewage, e. g. packinghouse, tannery, etc.................3.0 cu. ft. per gal.
Strong packinghouse wastes........................4.0 cu. ft. per gal.
Strong tannery wastes containing a very large proportion of colloids but settled before aeration............6.0 cu. ft. per gal.

RE-AERATION OF SLUDGE.

The evidence is conflicting as to whether there be advantage to be gained from sludge re-aeration. If the sludge is dense, i. e. contains 2% to 3% solids, the air appears to accumulate in large bubbles and escape from the surface at irregular intervals. This tendency seems to render the air less effective as a means of agitation and possibly interferes to some extent with the uniform distribution of the dissolved oxygen throughout the sludge. A test at Milwaukee indicated that there was not sufficient advantage to warrant the adoption of this feature.*

On the other hand, Pearse found† that in the treatment of Packingtown sewage the return of re-aerated sludge showed "somewhat smaller requirements in the amounts of air needed, and a reduced volume of sludge to be returned."

If the rate of air supply be uniform throughout the 24 hours the lower flow of weaker sewage at night will permit the sludge to become more thoroughly activated than during the day-time and in effect accomplish the end sought in the re-aeration of the sludge by treatment in separate tanks. Similarly on Saturday afternoons, Sundays and holidays the sludge may be revived by appropriate treatment. This result is obtained in practice and has been very noticeable and beneficial in some cases.

*T. C. Hatton, An. Rept. Sew. Comn. Milwaukee, Jan. 15, 1920, p. 38.
†Eng. News-Rec. Vol. 79 (1917), p. 777.

PECULIARITIES OF FLOC.

The little sponge-like aggregations of fine suspended and colloidal matters have no regularity of structure but are merely masses of independent particles held together by slight forces of attraction. They are of great size in relation to the weight of the solids composing them. The forces by which the particles are held together are so slight that the sludge must not be very vigorously agitated or the floc will be broken up. This is readily demonstrated by shaking a portion of the flocculated liquid in a bottle, when the floc will be seen to revert to the colloidal condition. Hence it is necessary to avoid intense agitation in aeration tanks and to induce as little violent agitation as upracticable when pumping and otherwise handling the sludge or the sewage after the sludge has been introduced into it.

The character of the floc varies greatly under different conditions. That produced by thoroughly aerating sewage for such a period of time and under sufficiently favorable conditions as to produce a highly purified effluent will usually be of a golden-brown color, relatively compact and heavy, and will settle with surprising rapidity. On the other hand under-aeration will produce a light, voluminous floc which will not settle as rapidly and which will form a very voluminous sludge of high water content and correspondingly difficult to handle. Under-aeration may be due to furnishing too little air or to too short a period of aeration due to crowding too great a volume of sewage through tanks provided with the proper air supply and period of aeration for a smaller quantity of sewage. The effect of low temperature is similar to that of under-aeration and in northern climates there is usually greater difficulty in producing a good sludge in winter than during other seasons. Such a condition may be caused temporarily by the introduction into the sewers of cold water from melting snow. An activated sludge plant should be designed with an adequate factor of safety to meet such conditions.

It is just as important to avoid over-aeration, for this results in a resolution of the floc into colloidal matter with a consequent poor effluent.

The condition of the floc is very dependent upon the sedimentation process. If the sludge is allowed to remain too long without air it loses its activity and becomes septic. It is therefore important to provide for the removal of the sludge from the sedimentation tanks as promptly as is consistent with the proper concentration—in fact, the extent of concentration is limited by the need of maintaining the sludge in good condition.

DURABILITY OF DIFFUSER PLATES.

It will be remembered that during the early tests porous plates used as air diffusers became more or less disintegrated within a relatively short period of time. In other cases such plates became so seriously clogged that the pressure necessary to force the required quantity of air through them, became prohibitively great. This was due in part to impurities in the air and in part to rust or other material from the plate holders, which gradually sealed the pores of the plates. At Houston, Mr. Fugate has found that porous plates clogged with rust can be cleaned by emersing them in hydrochloric acid at 98° C.*

Improvements in the manufacture of plates, appear to have overcome danger of disintegration, and experience during the past three years has demonstrated that it is

*Eng. News-Rec. Vol. 84, p. 754, 1920.

practicable to so purify the air and construct the plate holders as to avoid danger of clogging within a short time. The period covered by this experience, however, is too short to show how long a life such plates will have. However, in view of the fact that after continuous use for a period of about two years there is no marked increase in the pressure required to drive the air through the plates, the assumption seems to be justified that the plates will have a useful life of a number of years—certainly as many as five years and possibly a very much longer time.

It should be a source of satisfaction that so many of the causes of trouble with the diffuser plates have been discovered and means devised for remedying them. It is important, however, in designing activated sludge plants in which diffuser plates are to be used, to give very careful consideration to the manner of setting the plates and of cleansing the air.

PREPARATORY TREATMENT BY FINE SCREENING.

A very important advance has been made by demonstrating that it is possible to remove sufficient of the heavy and coarse solids of strong municipal sewage, by means of grit chambers and fine screens, to prevent the accumulation of deposits upon diffuser plates which are supplied with air at the rate of 1 cu. ft. per minute per square foot of plate area. This assures the successful operation of aeration tanks which prior to this demonstration was open to some question in cities where there is a very large proportion of heavy settling solids.

There is opportunity for further investigation to determine whether the quantity of air required can be materially further decreased by finer screening, than that which has already been employed. This would appear to be a promising field for study.

In some cases—particularly where industrial wastes, such as those from tanneries and packing houses are present—the advisability of sedimentation as a means of preparing the wastes for aeration ,is worthy of careful consideration. Some such wastes contain very large quantities of coarse and heavy suspended matter, and it is possible, and in some cases probable, that preparatory sedimentation may result in a substantial saving in air and may possibly also be so important as to make the process practical where without such preparatory treatment it might prove impractical.

SEDIMENTATION—REMOVING FLOC.

Obviously it is necessary to remove the floc in order to produce a satisfactory effluent—it would be folly after having gone to the expense necessary to form the floc, to allow it to escape with the effluent and thus nullify the work done in the first stage of the process.

The character of the floc—whether of light weight and voluminous, due to under-aeration or low temperature, or heavy and compact ,as a result of thorough aeration under favorable conditions, has an important, if not vital, effect upon the sedimentation process. If the floc is light and voluminous it settles less rapidly, is more easily carried over the weirs in the affluent, and, most important of all, it fails to consolidate and become compact as it accumulates in the tank. Generally a well-activated sludge settles very rapidly and forms a relatively compact or dense sludge.

A good floc may form a sludge containing as much as 3% solids and readily forms one of 2%, while a light, fluffy floc will often produce a sludge of 1% and

sometimes of only 1½% solids. The difference between sludges from under-aerated and well-aerated sewage is readily appreciated when the volumes of sludge to be handled are considered. The volums which commonly occur, based upon a uniform quantity of suspended solids, are given in Table 1.

TABLE 1.—RELATION OF VOLUME OF SLUDGE TO PROPORTION OF TOTAL SOLIDS.
(Original Sludge 2% total solids; dissolved solids 800 p. p. m.)

Water in Sludge, %	Total Solids in Sludge, %	Suspended Solids in Sludge, %	Relative Volumes of Sludges of Different Densities, %	Volume of Sludge to be Returned to Afford Uniform Quantity of Suspended Solids, Gal. p. M. G. Sewage.	Volume of Sludge to be Wasted. Gal. p. M. G. Sewage.
99.5	0.5	0.42	100	909,000	68,200
99.0	1.0	0.92	46	418,000	31,400
98.5	1.5	1.42	30	273,000	20,500
98.0	2.0	1.92	22	200,000	15,000
97.5	2.5	2.42	17	155,000	11,600
97.0	3.0	2.92	14	127,000	9,500

The volumes of sludge to be returned and wasted, as indicated by Table 1, are based upon the assumption that these volumes will be equivalent to 20% and 1.5%, respectively, of the sewage treated when the sludge contains 2% total solids.

The importance of providing a relatively dense sludge is obvious from these data. If 20% of sludge containing 2% solids be required, for the successful treatment of the sewage in the aeration tanks, and if for any reason the density of the sludge is suddenly changed to 0.5% solids, the volume which must be pumped into the sewage, to furnish the same quantity of suspended solids, will be increased from 200,000 to 900,000 gallons per million gallons of sewage to be treated, and all portions of the plant devoted to aeration, sedimentation and sludge return, must have capacities for this greater quantity, if the density be permitted to fall to this extent. Similarly, were it assumed that sludge having 0.5% solids can be dewatered with equal facility to that having 2% solids, equipment must be provided for handling 68,200 gal. of thin sludge per million gallons of sewage, instead of 15,000 gallons of normal sludge containing 2.0% solids. Furthermore, the indications are that thin under-aerated sludge is not as easily dewatered as normal well-aerated sludge. From the foregoing discussion it is clear that the success of the activated sludge process depends in large measure upon the production of a good floc and its efficient removal. So important is this phase of the treatment that it may well prove the controlling feature, and it may therefore be necessary to operate the plant primarily for the production of a good floc by providing such quantity of air and period of aeration as may be required for this purpose even though the quality of effluent produced be better than necessary.

In proportioning sedimentation tanks, four requirements should be kept in mind:

1. Opportunity must be afforded between the point of entrance and the point of exit, for the floc to settle sufficiently to prevent its being carried out of the tank with the effluent,

2. The rate of sludge withdrawal must be such as to retard the

travel of the floc enough to permit it to consolidate and form a relatively dense sludge,

3. There must be provision for drawing the sludge with sufficient rapidity to prevent its being delayed in passage to such an extent that it will undergo septic action which will render it less suitable for the treatment of the incoming sewage and particularly unfavorable for dewatering by methods now in use.

4. There must be sufficient tank capacity to provide space for the accumulation of the floc, which varies greatly from time to time during the day, according to the variation in the strength of sewage, as well as to other conditions, and also for the accumulation of the abnormally voluminous floc during brief periods of cold weather or under-aeration, neither of which can be entirely counteracted or avoided.

As stated by Mr. Hatton,* the proposed Milwaukee sedimentation tanks have been designed to receive aeration tank liquor at a rate sufficient to produce 1,600 gal. of effluent per 24 hours per square foot of gross internal tank area at times of maximum flow. The average rate of flow in dry weather will be about 850 gal. per square foot. In the demonstration plant the sedimentation tanks have received as much as 2,000 gal. of aeration tank liquor for substantial periods of time during which the effluent was satisfactory. The more conservative allowance for design, was adopted in order to provide for contingencies, such as a light fluffy sludge and changes in volume and quality of sewage. Some of these conditions may be coincident and last for a substantial length of time, as for example in the spring when snow is melting, the flow of sewage is high and its temperature is low.

Tests indicate that the floc from municipal sewage and from some industrial wastes, may be concentrated readily to a sludge containing 2%, and under favorable conditions possibly as high as 3% solids. To secure a greater concentration requires storage for so long a time that there is danger of septic action with its attendant evils. The safe limit of such storage may perhaps be taken at 6 hours, until such time as more data bearing upon this specific point, become available.

SLUDGE LAGOONS.

One of the most interesting developments is the disposal of sludge by pumping it into lagoons at Houston, Texas.

At the South Side Plant, which was started in August, 1918, all of the sludge produced up to the time this plant was visited by the writer in July, 1919, had been pumped into one lagoon which was about 300 ft. long, 100 ft. wide and 7 ft. deep, with side slopes of about 1 on 1½. At that time there was no offensive odor from this lagoon. There was, however, the characteristic odor of algae, which appeared to be growing in considerable quantities. No water had been drawn off from the lagoon, the supernatant water was clear, many gas bubbles were being given off, and some sludge was being carried to the surface by the gas bubbles, but immediately subsided. There was no floating sludge.

At the North Side Plant, where the sludge has been run into three lagoons, conditions were substantially the same.

SLUDGE DEWATERING.

Perhaps the darkest spot in the entire process of activated sludge treatment is that of sludge dewatering, which has been studied at the Packingtown, Houston and

*Eng. News-Rec. Vol. 84 (1920), p. 994.

Worcester plants, and particularly by investigations covering a period of several years at the Milwaukee testing station. Notwithstanding all of the investigational work thus far done, this problem cannot be said to have been satisfatcorily solved at the present time.

It has been repeatedly demonstrated that well-activated sludge can be dewatered more advantageously than an under-aerated or a stale septic sludge. It is accordingly necessary to so operate the plant, insofar as practicable, to avoid under-aeration, prolonged storage which tends to cause septic action, and probably also over-aeration which tends to resolve the floc into its colloidal condition. It is probable that the plant must be operated with a view to producing the sludge in a condition to be most readily dewatered, although there is promise that a poor sludge can be conditioned so as to be successfully dewatered.

One phase of the magnitude of the sludge disposal problem may be readily appreciated by a comparison of the nominal volumes of sludge produced by the several processes of sewage treatment now in use, Table 2.

TABLE 2.—NOMINAL VOLUME OF SLUDGE PRODUCED BY DIFFERENT PROCESSES OF SEWAGE TTEATMENT.

Treatment Process	Nominal Volume of Sludge, Gal. per Mil. Gal. of Sewage Treated	Proportion of Solids in Sludge	Specific Gravity of Sludge	Weight of Dry Solids in Sludge, lb. p. Mil. Gal. of Sewage Treated
Activated Sludge	10,000	2.00	1.005	1,675
Chemical Precipitation	5,000	7.50	1.040	3,250
Sedimentation	2,500	5.00	1.020	1,060
Septic Tank	500	5.00	1.040	220
Imhoff Tank	500	15.00	1.070	670
Trickling Filter—Humus Tank	500	7.50	1.025	320

While it is recognized that the volume of sludge produced by any of these processes will vary materially according to local conditions, and particularly to the proportion of solid matter removed from the sewage, the activated sludge process, under all conditions, is likely to produce a very much greater volume of sludge than any other process.

For the dewatering of activated sludge consideration may be given to the use of four types of machines,—the plate or standard filter press, the squeeze press commonly know nas the Worthington or Berrigan press, the Schaefer-ter-Meer centrifuge and the Besco-ter-Meer* centrifuge.

The plate press consists of a large number of thin round or square cast iron plates, concave on both sides, supported in vertical position upon two horizontal side rods. The plates are covered on both sides with cotton duck and when forced tightly together in closed position, form thin chambers into which the sludge is pumped under a pressure of about 100 lbs. per square inch. The water of the sludge is forced through the duck and escapes by means of corrugations on the faces of the plates and holes cored in them. The solids are retained upon the cloth and gradually form a very compact cake. After the cake has begun to form in this manner, the water must pass through it as well as through the cloth, in order to escape. When the sludge is fresh, well-activated and in most favorable physical

*A modification of the Schaefer-ter-Meer centrifuge deriving its modification in name from the Barth Engineering and Sanitation Company, American agents.

and chemical condition, a cake about 1 inch thick may be formed in about two hours. Under such conditions the cake is easily separated from the cloth, leaving it relatively clean for the next pressing. Under other conditions the sludge has entirely different characteristics and may require 4 or 5 hours for the formation of a cake and even then the cake may be so moist that is cannot be removed without leaving the cloth smeared with slimy sludge and in poor condition for further use, if indeed it can be so used without previous washing. The sludge may be in such condition that its dewatering by this method is impracticable.

The squeeze press is of entirely different construction and operates upon a different principle. In this case a number of bags, open at the bottom, are held in position by supports at the top. Between each pair of bags is a corrugated drainage rack, also supported at the top. Preparatory to filling the bottoms of the bags are forced tightly together to prevent the escape of liquid sludge, which is then allowed to flow by gravity or under slight pressure into the bags, through small flexible tubes attached to a sludge pipe header at the top. During the filling, which is done slowly, a portion of the water escapes through the cloth. When the bags have become filled, the sludge supply is shut off and pressure is applied to all the bags, by means of two end platens which are forced toward each other under considerable pressure, thus squezing the bags and forcing the water out through the cloth, whence it escapes through the vertical corrugations in the drainage racks. In this way the water is squeezed out of the sludge in a manner similar to that employed in the home-made "jelly bag," leaving a rather homogeneous mass of moist solids. There is no formation of compact cake on the inner surface of the cloth, as in the case of the plate press. When the sludge is in favorable condition the pressing may be completed in approximately 4 hours. Dewatering by this type of press does not appear to be so greatly affected by unfavorable condition of the sludge as in the case of the plate press, although the time of pressing is materially increased and the cake usually contains more moisture.

In the original Schaeffer-ter-Meer centrifuge the sludge is admitted to a revolving drum which is closed at the top, and is subdivided into radial compartments each of which has a perforated plate or screen through which the water is thrown by centrifugal force. The solids form a cake on the perforated wall of the chamber, in much the same manner as the cake is gradually formed in the plate press. The water must pass through this cake in order to escape.

The Besco-ter-Meer cetnrifuge is similar in general mechanical construction to its predecessor, the Schaefer-ter-Meer, except that the drum is open at the top and is not subdivided into compartments. There are no screens or perforations. In this case the solids are thrown, by centrifugal force, against the wall of the drum, where they gradually build up a cake, leaving the water in the center of the drum to be thrown upward and over the top by centrifugal force. In this type of centrifuge it is obvious that it is not necessary to force the water through the cake, as in the case of the Schaefer-ter-Meer centrifuge or the plate press.

Experiments with Besco-ter-Meer centrifuge show that it is possible to secure a cake of from 80% to 85% moisture. However, the centrifuge effluent contains a very large proportion of the original suspended solids,—from 80% to 50%. There seems to be a segregation of solids, the larger and heavier particles being formed into cake and the lighter and finer matter remaining in the effluent.

It is extremely difficult to remove this residual matter by subsequent centrifuging either by itself or when mixed with fresh normal sludge.

ACIDIFICATION OF SLUDGE.

Activated sludge is normally slightly alkaline and it has been found that its

natural slimy characteristics can be counteracted in a measure by acidification. The quantity of acid required will vary according to conditions, but in general, if sulphuric acid is used it may be taken at about 0.12% by volume of the sludge to be dewatered. If it be assumed that the waste sludge will be equivalent to 1.5% of the sewage treated, or 15,000 gallons per million gallons of sewage, the quantity of sulphuric acid required, upon this basis will be about 1.2 gal. per thousand gallons of sludge, equivalent to 270 lb. of commercial sulphuric acid per million gallons of sewage. At 1c per pound, the cost of acid will be about $2.70 per million gallons of sewage treated.

The cost of acoid may offset in part, or peralips wholly, by an increase in ammonia content of the dried sludge. This is because of the neutralization of the alkalis with acid, after which heating in the drier does not drive off the nitrogen in the form of ammonia, as is the case when unstable nitrogeneous compounds are heated in the presence of alkalis. The gain in ammonia, due to acidification, while varying in different sludges, may be taken at about 12%.

There is likely to be another apparent increase in the ammonia content of the dried sludge, due to the effect of pressing, by which a substantial proportion of the solids in the sludge pass away in the form of press liquor. The proportion of nitrogen in these solids is somewhat lower than that in the suspended matter due to the large proportion of colloids high in nitrogen in the latter. The removal of the dissolved solids, therefore, results in an increase in the proportion of nitrogen in the dry solids of the sludge cake over that in the dry solids of the original liquid sludge.

The effect of the apparent increases due to acidification and to pressing, when applied to the dried sludge containing 10% moisture and computing the value of the sludge at $4 per unit, are shown in Table 3.

TABLE 3.—ESTIMATE OF QUANTITY AND PRICE OF PERTILIZER FROM STRONG MUNICIPAL SEWAGE*

Volume of sludge, per m. g. sewage	15,000 gal.	
Proportion of dry solids	2%	
Weight of dry solids per m. g. sewage	2,500 lb.	
Weight fertilizer with 10% moisture	2,780 lb. equals 1.39 tons	
Proportion of ammonia in dried unacidified sludge containing 10% moisture (6% ammonia on dry basis)	5.4%	
Increase in ammonia, due to acidification	12.0%	
Ammonia in dried acidified slaudge	6.05	
Increase in ammonia due to pressing	9.0%	
Ammonia in dried acidified press cake	6.59	
Price per unit of ammonia	$4.00	
Value per Mil. Gal. of Sewage—		
Fertilized—nominal—unacidified, unpressed, dried	$30.02	
Fertilized—nominal—acidified, unpressed, dried	$33.64	
Difference, due to acidification		$3.62
Fertilizer—acidified, pressed, dried	$36.64	
Difference, due to pressing		$3.00

It therefore appears that there is a theoretical increase in value of $3.62 per million gallons of sewage, due to acidification. If the price be taken at $2 instead of $4, per unit of ammonia, the difference would be but $1.80—hardly enough to pay for the acid.

Present indications are that the return from the sale of fertilized will partially, and perhaps wholly, offset the cost of dewatering and drying the sludge, but that

*No allowance for losses.

there will probably be no surplus applicable to the operation of other features of the plant.

SLUDGE DRYING.

Sludge drying is similar to the drying of many other materials, which has been thoroughly developed in the arts. There does not seem to be any problem peculiar to the drying of sludge. There is, of course, the danger of burning the sludge, of creating objectionable odors, and of the escape of considerable dust. Care in manipulating driers designed for the purpose, should reduce to a minimum the liability of burning or scorching the sludge. If the gases from the driers are passed through suitable dust chambers and are thoroughly washed, dust can be entirely eliminated and there does not seem to be danger of dissemination of disagreeable odors. It will, however, be advisable to discharge the washed gases through a relatively high stack.

MANAGEMENT.

One of the most serious inherent dangers in the application of this process, lies in its management. The process is complicated by a large number of steps, each more or less dependent upon the preceding one. Skillful conscientious, technical management will be required to keep al features operating to best advantage, with the marked variations in volume, character and temperature of the sewage, and the multitude of ordinary operating difficulties.

It remains to be demonstrated whether such a process can be successfully operated as a commercial project under municipal conditions generally prevailing in the United States. To assure success it will be necessary to enter the market and dispose of the commodity produced, as advantageously as the laws of supply and demand will permit. Prices are subject to radical fluctuations, but the costs under municipal control will probably not fluctuate in a commensurate manner. The one thing which is assured from the outset is a very substantial cost, but it may be hoped that enough revenue will be derived to so reduce operating expenses as to prevent them from becoming an unreasonable burden.

TWO IMPORTANT ADVANTAGES.

There are two very important advantages of the activated sludge process—the production of a well-purified effluent of attractive appearance, and the complete disposal of the sludge. These advantages are well worth striving for. At present it would seem that this process is particularly worthy of consideration where such an effluent is desired, and where power may be obtained at moderate cost. Obviously it is an advantage for such a plant, to be situated in a district where large quantities of fertilizers are used, thus avoiding the necessity of shipping the sludge long distances.

OPPORTUNITIES FOR IMPROVEMENT IN PROCESS.

There appear to be two features which give promise of great improvement, on further investigation—the aeration and agitation of the sewage, and the dewatering of the sludge. It may be that the former can be accomplished by some sort of mechanical agitation accompanied by the use of a small quantity of air to maintain aerobic conditions. This would seem to be more easily applied to a small plant than to a very large one like that at Milwaukee, although if the saving in operating expense is sufficient, the size of the plant would probably not offer an insurmountable obstacle to the adoption of such a method.

At present the hope of improving the method of dewatering appears to lie in the direction of conditioning the sludge rather than improvement of mechanical appliances, although the latter subject should by no means be neglected.

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TECHNICAL PAPERS

CURRENT TENDENCIES IN SEWAGE DISPOSAL PRACTICE

By George W. Fuller*

Presented May 16, 1921.

In the midst of the reconstruction period following the great war, it is helpful for engineers to outline and discuss the trend of developments of various lines of work, in order to get a better perspective on past and future performances. It is wise to appreciate that nearly seven years have elapsed since the outset of the world war when financial, economic and industrial conditions became seriously disturbed throughout the world; and that it is four years since our own country encountered the upheavals incident to active participation on a large scale in military operations. We now have unsettled conditions in the industrial field, with three to five per cent of our total population out of employment and with irregular price trends in different commodities. Many persons are occupied in various ways in getting activities back to something like a normal basis.

In the field of municipal sanitation, progress was abnormally small during the war period. With a few notable exceptions construction work during the war period was limited to imperative demands. Procedures for new undertakings are now being considered, with more need than ever before that programs and plans be formulated wisely.

The purpose of this talk is not to plunge into technical details but rather to outline what is of more importance at this stage and that is a summary of experiences recently obtained in this field of engineering so as to indicate how they can be taken advantage of most helpfully as a guide to future developments.

NEED FOR MORE COMPREHENSIVE PLANNING.

We all appreciate the rapid strides which have been made in recent years in city and town planning. We are aware that a number of the large cities have accomplished much in formulating definite construction progrems for adoption from time to time as local conditions demand. But a striking feature at present is the unusual extent to which small and medium sized cities are setting about to develop

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a program for improved sewerage and sewage disposal. Many cities in this country have previously carried out their work in this branch of engineering in a more or less haphazard manner and with meager or faulty records of what was done. Changes in the personnel of the office of the City Engineer were frequent and there was no particular incentive to do better planning and to develop a coordinate comprehensive program as to plans and general designs. There is no increase necessarily in the amount of construction work actually put under contract year by year by adopting a program and essential features of design, developed for the next ten to twenty years or more, and so that current construction work will dovetail in with past and future work, regardless of date of construction or of personnel in office at the time when the work is undertaken.

This present phase of American practice in the field of sewerage and sewage disposal is very gratifying. It approaches that which has been characteristic of many of the best managed cities in Europe for many years and will undoubtedly save much money for taxpayers in this country, as well as afford them greater benefits from the work done.

STATE LAWS.

State laws and the interpretations of them have recently been helpful in advancing sewage disposal practice. In an increasing number of states there are now laws whereby cities are ordered or urged to proceed to eliminate nuisances due to the fouling of neighboring bodies of water. Of course such laws have prevailed in some states for many years but their enforcement has been frequently less efficient than should have been the case. Too often actual or threatened lawsuits from riparian owners have alone brought forth betterments in the field of sewage disposal.

In several states real progress is being made toward getting sewage disposal practice on a higher plane, as a result of more favorable conditions for financing the projects. In Ohio, where such projects are ordered by the State Department of Health, the cost is not included with those bonds for which there is a limit in relation to percentage of assessed valuation. In other states, such as Illinois and Indiana, the creation of Sanitary Districts facilitates financial arrangements.

Where a state or other authority tries to get too much accomplished at one time either as to quantity or quality of performance in this field, disappointment has frequently been experienced. This shows the need of a coordinated program, the adoption of which can be progressive as circumstances and finances warrant. It is well to remember that the Rivers Pollution Act of Great Britain of 1876 called for complete purification of sewage with the result that progress was comparatively slow for many years, owing to the expense and uncertainty as to how to proceed. In our own country there have been two groups in the field of sewage disposal, advocating views somewhat at cross purposes—one group wanting complete purification and the other wishing to eliminate gross nuisances and gradually to install betterments as local circumstances permit or warrant. It is not those authorities which have set out to accomplish too much at first that have the best record of performances as to betterments in this field. On the contrary those which have gotten local authorities to develop an orderly program for progressive installation of sanitary works have in the long run the most to show for their effort. This has been true in the past in a sufficient number of cases to convince me that this is wise, particularly at the present time when funds are limited for constructing all of the various municipal works which the cities desire to undertake.

In the middle west it is worthy of note that legislation in several states now enables the creation of sanitary districts. This permits municipalities or groups of municipalities to arrange financial programs somewhat independent of restricted municipal bonding capacity and in other ways is helpful in getting works built. This follows the creation abroad of the river boards and conservancy districts and drainage districts and is comparable with the Metropolitan Sewerage District of Boston, the Passaic Valley and other joint projects in New Jersey. In some cases joint projects are possible where a multiplicity of single projects would be difficult or impossible to execute.

PREVAILING VIEWPOINTS AS TO OBJECTS SOUGHT.

Mention has already been made of the waning influence of those who set out to bring about complete purification of sewage. Such a result is necessary under some circumstances but frequently the benefits are not commensurate with the cost, and efforts to bring about such a situation have sometimes worked against any substantial progress at all being made in even urgent cases.

The war period saw numerous efforts made to reduce waste and to utilize many products to which but little attention had previously been given. Among such subjects is the utilization of sewage in relation to irrigation and its fertilizing properties. These have crept out in the press from time to time in a number of cases recently, as in earlier years, and particularly at Los Angeles where mention will be made of them a little later on.

As to the objects sought by sewage disposal practice there was never a more helpful status than at present. By that is meant that the elimination of nuisance is now being generally sought, so far as conditions offensive to sight and smell are concerned. It is also true that the protection of water supplies, bathing beaches and shell fish layings require more complete treatment in some cases than is necessary to produce what might ordinarily be called clean bodies of water, and that such cases are given consideration. But with elimination of the idea that "spring water" must always be produced it is confidently believed that substantial progress will be made more rapidly than ever before in correcting deficiencies in this branch of municipal sanitation.

RATIONAL UTILIZATION OF THE NATURAL RESOURCE AFFORDED BY OXIDIZING POWER OF WATER.

In Chicago the dilution method of sewage disposal has had for thirty years or so a local definite status which, subject to certain limitations, is rational and proper.

To avail reasonably of the dilution method it is known that sewage solids should be removed to an extent not appreciated a few years ago. It is further realized that more intimate mixing of clarified sewage with the diluting water is necessary in order to bring about satisfactory results. While we hear much about advances in the art of sewage treatment by processes applied on land it is not to be forgotten that real progress has also been made in the discharge of sewage into relatively large bodies of water so as to avoid offense.

Reference is made to the growing custom of making use of submerged outfalls in deep water and for large projects of adopting multiple outlets to facilitate prompt and complete mixing of clarified sewage with the moving water into which it is discharged. Comparison of these with the shore outlets af earlier years with their

stranded sewage solids both above and below the water line causes us to appreciate in some measure what has been accomplished by the deep submerged outlets at Toronto, Rochester, Cleveland, Deer Island in Boston Harbor, New Bedford, Washington and many smaller places. Deer Island experiences are markedly favorable to the new multiple outlets in deep water.

A rational utilization of the natural oxidizing powers of large bodies of water is further emphasized by the recent decision of the United States Supreme Court, not to enjoin the Passaic Valley project by which the sewage from an ultimate population estimated at 1,600,000 people is to be discharged in a depth of about 40 feet of water through 150 specially designed nozzles located over an area of some 3½ acres on the bottom of the upper New York Bay. It is interesting to point out that this long-drawn out controversy between the states of New York and New Jersey, which is said to have cost New York $152,000, terminated in a manner which will allow the operation of a project which marks a substantial step in advance as to sewage disposal practice and one which the city of New York is itself striving to put in practice as regards general method of procedure.

In this Passaic Valley litigation an enormous amount of technical data was produced in 1911-13, costing the city of New York $20,000 to print and which undertaking for lack of appropriation consumed four or five years. In fact some ten years elapsed between the filing of this suit and the first argument on it during the winter of 1918-19.

The court recognized the rapid advances being made in the field of sewage disposal and on March 10, 1919, decided that additional testimony should be taken in order that the court might be advised: "(1) As to any practicable modification of the proposed sewer system which might improve it and reduce any polluting effect upon the water which might be caused by the effluent to be discharged; (2) as to any practicable plan or arrangement for sewage disposal which would lessen the polluting effect derived from the New York City sewage; (3) and as to the present degree of pollution of the waters of New York Harbor and the change in this respect since the taking of the testimony was closed."

The decision of the court shows that the water near Robbins Reef Light in upper New York Bay in 1919 was somewhat affected by the discharge of local sewage but in the interval from 1906 to 1919 the growth of New York City approximated the total population estimated for the Passaic Valley Sewerage District in 1940 with the result that the 1919 conditions in the harbor had not become so pronounced as to sustain the views of complainant in their earlier testimony and allegations as to the effect of the added sewage to come from the Passaic Valley.

Stress was laid on the contractual obligations of the Passaic Valley Sewerage Commission to operate this enterprise so as to fulfill certain stipulated and stringent requirements. And the fulfillment of these requirements is under the supervision of the Federal Government as provided in the stipulation by which the Government withdrew as an intervenor in the New York vs. New Jersey suit on this Passaic Valley project. This intervention was based on "the power and duty of the Government over navigation and interstate commerce, and the inherent power which it has to act for the protection of the health of government officials and employes at the Brooklyn Navy Yard, and its duty to protect from damage the government property bordering on New York Bay."

Emphasis should also be laid upon the concluding paragraph of the opinion of

the court which contains the suggestion that "the grave problem of sewage disposal presented by the large and growing populations living on the shores of New York Bay is one more likely to be wisely solved by co-operative study by conference and mutual concession on the part of representatives of the states so vitally interested in it than by proceedings of any court however constituted."

It is pointed out that the experts of the opposing parties agreed that the amount of dissolved oxygen in water is the best index of the degree to which it is polluted by organic substances but opinions vary from 25 per cent to 50 per cent of saturation as the amount of oxygen necessary to prevent the appearance of offensive odors from decomposition of organic matter.

RELATION TO WATER SUPPLIES.

The work of International Joint Commission which was set up by the treaty of 1909 between Great Britain and the United States has featured the relation of sewage disposal in the light of bringing about a degree of purification such that neighboring water filtration plants on boundary waters between the United States and Canada would not be overloaded. This undertaking arises from the provisions in the treaty which state that "the water herein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other."

The final report of this Commission prepared in 1918 has not been adopted by our Federal Government. This report suggests a tentative standard as to bacterial content in the water into which purified sewage is discharged. The individuality of local conditions is recognized and also the right of local authorities, subject to review by some supervising authority to exercise their own judgment within reasonable limits as to remedial measures, rather than to set up a fixed standard. The proposed bacterial standard of 500 B. coli per 100cc of water as an annual average has never received much support due largely to the differences in bacterial methods now in vogue, as compared with those practiced in Lawrence, Mass., and other places in earlier years.

Another factor of considerable significance is that soil bacteria which are found in Southern and Western rivers cause the results obtained at many municipal water plants to throw considerable doubt on the reasonableness of the proposed International standard, notwithstanding that conditions in large lakes are so different from those in flowing rivers that there is not necessarily much similarity in the conditions involved. When these muddy waters are settled the bacterial results are more nearly comparable with those suggested above.

Unquestionably it is desirable to keep to a reasonable minimum the degree of pollution of a public water supply so far as sewage is concerned. This is shown by the findings of the Board of Engineers which reported last year at Philadelphia and advised that the polluted Schuylkill river be replaced as a source of city water supply as soon as practical by impounded waters from tributary streams. Even in this case it is trade wastes which interfere with obtaining a satisfactory effluent, although the sewage is a factor influencing the standing of the filtered water. At the same time it is to be remembered that hygienically there are many water filter plants which produce a good safe effluent from waters drawn from polluted sources.

At the outbreak of the war the City of Buffalo was about to undertake extensive investigations into various details involved by its sewage disposal and water

supply problems in relation to the jurisdiction of the International Joint Commission. It is worthy of note that Buffalo is now pushing actively towards the adoption of a water filtration plant for its water supply rather than the development of a program for sewage treatment.

Load factors which may be safely carried by water filtration plants, with reasonable allowances for a factor of safety, have been influenced, of course, quite markedly by the introduction of chlorination procedures. These tend somewhat to make filtration processes serve as clarifying agencies primarily and secondly as arrangements for removal of bacteria. Recent investigations on a small scale show that the coagulation of waters and their preparation for filtration can be improved by the methods of the electro-chemist, who finds that when the right hydrogenion concentration in the water is provided, not only is a smaller amount of coagulating chemical required, but that impurities in the water are segregated in a form which permits of more advantageous filtration than hitherto indicated. To what extent such studies and methods are readily negotiable on a practical scale remains to be seen. The tendencies are towards the universal sterilization of water, with water filtration practice on a higher plane than formerly, which may have ultimately quite an effect upon sewage treatment practice. Whether the latter should prove true or not, it is worth noting that efforts of the sizeable cities to secure clean pure water are now making water filter projects about as active as they were before the war.

RELATION TO TRADE WASTES.

In this country it has generally been the practice for large industrial establishments to discharge their wastes into sewers or water courses, if more convenient, in such manner as they pleased, with but little or no regulation from City or State authorities corresponding to efforts made at quite a number of places abroad.

The significance of trade wastes varies materially. In many municipalities the quantity and quality are such that the effect is negligible. Here is Chicago, for instance, the load on the Drainage Canal, due to the wastes from Packingtown and the Corn Products Refining Company at Argo, is reported to be about 50 per cent greater than would be the case without these two groups of industrial wastes, which have a combined effect equal to the normal sewage of nearly 1,400,000 people.

Gas house wastes during the war were kept out of the sewers and streams to a greater extent than formerly was the case due to efforts to recover products sought by the munitions industries. Even at a period when there was a financial object to retain and recover these products there were "spills" at the gas works from time to time which had a disturbing influence, either upon the flow of the local sewers or neighboring bodies of water used as a source of water supply or both. The experiences at Milwaukee, Toronto and places in Pennsylvania indicate that there are real problems to be solved in the field of industrial wastes, both from the standpoint of sewage disposal and public water supplies. Perhaps it is this phase of municipal sanitation that promises to receive the greatest degree of increased consideration.

The Passaic Valley Sewerage District was created by an act of the Legislature prohibiting the entrance of gas house wastes into the trunk sewer. This simplified the local sewage treatment procedures, but in some localities this style of handling is not feasible. In consequence the solution of the problem will vary at different localities.

The enormously rapid growth of the automobile industry and the increases in manufacturing in certain centers have brought to the front a number of problems which emphasize the effect of trade wastes. Not only do inflammable gases, such as arise from gasoline and similar products, threaten serious results in connection with explosion of sewers, but the mineral oil content in a number of places seems to be of substantial importance as regards the treatment of sludge for use as a fertilizer and as affecting the saleability of greast recovery products.

In connection with this question of trade wastes it may be well to point out that the growth of industries in some localities has produced a substantial effect upon the streams which have become acid to a greater degree and for longer periods than was the case a few years ago. This is particularly true of the coal fields where the sulphur in the mine drainage and washings from coal handling operations becomes oxidized to sulphuric acid. In Pennsylvania but little effort was made for years to restrict the acidification of streams by the coal industry. A year or so ago a suit was instituted against a large coal company by the Mountain Water Supply Company, a subsidiary of the Pennsylvania Railroad, which developed a water supply on Indian Creek for railroad purposes along the Monongahela Valley from Connellsville to Pittsburgh. Above the storage reservoir on Indian Creek are located the coal mines of the defendant company. It is understood that this is a test case of unusual importance in relation to trade wastes as affecting the quality of streams.

INTERCEPTING AND OUTFALL SEWER CAPACITIES.

Waterworks men have for many years made strenuous efforts at many points to reduce the needless use and waste of water. Thereby they have provided a reserve in the capacity of supply work at a figure less than would be possible by new extensions or by any other means. This has been brought about by meterage, waste surveys, house to house inspection, pitometer studies and the like.

In sewerage practice, engineers for a long time have urged that roof water from houses should not be discharged into sewers of the separate type, and have made increasing efforts to guard against the entrance of ground water into sewers for the reason that not only is the margain of reserve capacity of sanitary sewers correspondingly reduced, but particularly for the reason that the costs of sewage disposal works and of pumping are proportionately increased.

At a number of places I have had occasion recently to appreciate the importance of sewerage engineers taking just as careful pains to reduce the quantity of sewage flow especially for peak conditions as in the case of water works. By so doing it is possible in some cases to defer for some time the expense of new construction work and in other instances as at Los Angeles it is imperative in order to lessen the peak rates of sewage flow and thus prevent serious surcharging of the outfall line during the period required for the construction of a new one. The extraordinarily rapid growth of Los Angeles accentuates a number of such features which are not ordinarily conspicuous in cities of normal growth.

In these efforts to control or reduce peak flows the rate at which trade wastes are discharged into the sewer system is a feature of much importance and in some cases it is perhaps wise if not necessary to reduce the volume of water in use for flushing sewers, particularly with automatic flush tanks.

At Kansas City last summer, where there was a very small margin of reserve

capacity in the supply works of the city water plant, the automatic flush tanks were shut off and some five or six million gallons of water pere day were thus saved. A few of the flush tanks were put back in service but the vast majority of them were found to be unnecessary. Without attempting to generalize on this question, or to compare flush tanks with hand flushing with a hose from hydrants, or to discuss the advantages of using sewage itself for flushing through building up a head of sewage by means of quick-opening gates in manholes, it is very clear that sewerage engineers have much work to do in some localities in the reduction of quantity of sewage flow.

UTILIZATION OF SEWAGE.

Since the earliest days of water carriage for the removal of household wastes there have been frequent and strenuous discussions of the practical economy of using the fertilizing properties of sewage and also, in arid or semi-arid regions, of using the sewage as a substitute for irrigation water. The war period with high prices for fertilizers and of construction work for irrigation projects again brought the utilization question to the front as a number of places both in this country and abroad. As a general proposition the answer, however, has remained the same; and that is that, perhaps excluding some exceptional cases, it is more expensive to put sewage in form so that its fertilizing and irrigating properties can be utilized than it is to secure for agriculturists equal benefits in other ways. These questions have arisen recently in Los Angeles and brief comment will be made on each topic.

Grease recovery is successful at Bradford, England, and a few other textile places, but tests at Boston and New Haven and experiences before the war in Germany have not established the basis of commercial success. Mineral oils in the sewage are a drawback.

SEWAGE IRRIGATION.

In the semi-arid districts of this country it appears safe to state that there is less rather than more sewage used for irrigation than was the case fifteen or twenty years ago. It appears that there are some 64 cities in California, nearly all of them small, which dispose of some portion of their sewage on land and it is stated that nearly all produce nuisances and are a source of net expense rather than profit. Sanitary authorities have taken and continue to take a strong stand against the use of sewage in an untreated condition for irrigation of lands on which are grown vegetables that are eaten uncooked. Transmission of disease by flies for a considerable distance from sewage farms is another objection. It is certain that farmers will make use of sewage only at those times when it is beneficial to their crops and during the remainder of the time the sewage is diverted to the most convenient place for its disposal, with resulting complications as to odors of decomposition.

A few years ago I found that at San Antonio the sewage of the city was discharged into Lake Mitchell, from which a mixture of sewage and stream flow was diverted to lands in the neighborhood for purposes of irrigation. I am now informed that the quantity of sewage so utilized has decreased rather than increased recently.

At Los Angeles sewage has not been used for irrigation for more than fifteen years. In that general locality there are lands in need of more water than they now receive for purposes of irrigation. That is not true however in the immediate

locality where some 200 second feet of water from the Owens River Aqueduct is sent through the hydro-electric plants and thence wasted into the Los Angeles River for some eight or nine months in the year because of lack of irrigation demand. During the three or four driest months, during the cropping season, there is demand for additional supply of irrigation water. The aqueduct water is sold by the city for irrigation purposes at about $6.00 per acre foot or approximately $18.00 per million gallons. Consideration of this figure in comparison with the cost of conveying purified sewage to lands requiring irrigation shows that there is no margin for profit to say nothing of the responsibility of disposing of the sewage in a hygienic manner during the eight or nine months of the year when the irrigation demand is very small. However, it may be that in exceptional localities in the future sewage irrigation with purified sewage may be worth while, notwithstanding that general evidence now points to failure as a commercial propostion.

SEWAGE SOLIDS FOR FERTILIZER.

For more than sixty years efforts have been made to put on a commercial basis the recovery from sewage of its fertilizing properties. Numerous early salvage projects in England were promoted by companies organized to develop this enterprise. The results practically without exception were a failure. The Royal Commission on Sewage Disposal, after nine years' experimentation, arrived at negative conclusions, so far as the economical aspects of the proposition were concerned. In 1918 a committee of the National Salvage Council of the British Government investigated sewage solids at a number of plants with the conclusion that tank sludge has a definite fertilizing value although not sufficient to enable it to compete with artificial fertilizers in manurial value. In Europe sewage sludge was sold at many places before the war for from 25 cents to $1.00 per load but in this country the experiences have been not as promising. American farmers, particularly just before spring and fall plowing have teamed away more or less sludge from sludge dumps at various sewage disposal plants, but they have not been disposed to make much or any payment, or to consider the sludge worth carting more than a couple of miles or so. They seem to much prefer the artificial fertilized. Whether this is due to a desire to use something that they have more faith in, or whether it is the force of custom, or whether they believe that sewage sludge may not be suited for their own particular land, are difficult questions to answer. Some farmers object to sewage sludge on the basis that it conduces to the growth of weeds or tomato plants and other things that they do not wish to have established on their land. Another indication of the inertia to be overcome from the disposal of sewage sludge as a fertilizer arises from the fact that in some localities farmers will not remove hen manure from establishments that house a large number of fowls.

In artificial fertilizers plant food is found in quite readily available form whereas in sewage sludge the chief plant food, that is organic nitrogen, is only partially available and by no means as much so as results of analyses may indicate. Another complication in some cases arises through the presence in the sludge of grease and mineral oils.

Septicized sludge is apparently without value as a fertilizer to an extent to cover transportation charges for any substantial distance. A much better plant food is obtained from activated sludge or from the sludge from final settling tanks-following coarse stone filters. These require dewatering as will be briefly discussed beyond. Present low prices make a different outlook than during the war

period, as is actually being experienced at garbage reduction plants. High transportation charges limit the distance to which sewage sludge can advantageously be transported for use as a filler, so that this outlook is not as promising as it was a few years ago. Trade wastes and the composition of sewage solids makes the problem assume different aspects in different localities. This problem has been and will be studied at Chicago, Milwaukee, Indianapolis and probably Los Angeles with perhaps more thoroughness and on a larger scale than has ever been attempted hitherto. The activated sludge method produces a sludge much richer in plant food than most sludges previously studied and local trade wastes are helpful. But success at these cities is not necessarily a safe criterion for other and smaller cities.

CLARIFYING ARRANGEMENTS.

Two styles of arrangements are used for clarifying sewage either preparatory for dispersion by the dilution method or for treatment by filtration or other similar arangements. These are fine screens and sedimentation tanks. The former remove less of the suspended solids than do sedimentation tanks, but for some undertakings they produce an adequate amount of clarification and leave the removed solids in a form for more ready disposal than is the case with tanks where the solids are mixed with so much water as to make a difficult sludge to dispose of.

Fine screens have been installed or projected to a greater extent than have been tanks in those cities on or near the Atlantic coast. Around the Great Lakes tanks have been favored rather than fine screens. Relative costs, efficiencies and ease with which objectionable odors may be controlled in handling the sewage solids are features upon which opinions vary and must of necessity continue to vary with experiences founded upon varying local factors. It is sufficient to say here that there is a real field of usefulness for both fine screens and tanks, about each of which a few comments may be made indicating recent tendencies.

FINE SCREENS.

In this country fine screens have never reached the status which they have in Europe, although perhaps that view may be modified if recommended screening projects on a large scale such as at New York, Philadelphia and Los Angeles were to be advanced to the stage of actual accomplishments. Earlier experiences with screens in this country were disappointing at Reading and Brockton through lack of ability to give continuous service. The Reinsch-Wurl screen of European origin has been redesigned so that it has been in its more recent installations a durable and well-performing mechanism. The improvement over some of the earlier installations both in this country and abroad is marked. The 10 and 12-ft. diameter screens of this type, which have worked well at New York City, Rochester, and Plainfield, N. J., have given place in larger installations to units of greater size. At Bridgeport screens of this type of a diameter of 22 ft. have recently been installed.

The price of this type of screen has been such as to lead many engineers to consider recently the drum type of screen modified both structurally and in its operating arrangements from the earlier drum screens at Reading and Brockton. Several types of such screens are now offered, some of them with perforated plates, some covered with a fine wire mesh, some cleaned with jets of water, air or steam, and others designed to be cleaned by means of traveling brushes as is the case with the Reinsch-Wurl screen. Manufacturers of paper mill equipment have taken an

interest in this problem and views vary as to arrangements which will give satisfactory results at the least total cost when capital charges, operating expenses and renewals are taken into account.

Mention should be made of developments at Indianapolis where Mr. Hurd has devised arrangements for passing sewage into a compartment in which are located several screens through each of which a portion of the sewage is passed from the exterior to the interior of the screen, thus leaving in the screen compartment a portion of the sewage in which are contained the solid matters left behind by the sewage which passes out through the screens. Both at Indianapolis and at Milwaukee attention is being given to arrangements of this sort and to the handling of the "concentrate," or the unscreened portion of the sewage, amounting perhaps to 15 per cent of the total flow. With the consideration being given to fine screening at Staten Island, Milwaukee, Indianapolis, Los Angeles and other smaller cities, it is evident that the coming year is likely to witness important developments.

SEDIMENTATION TANKS.

Before the war most of the new and larger installations for the clarification of sewage by sedimentation were of the two-story type in which the flowing sewage passes through the upper chamber, with the solids dropping through a trapped slot into a digestion or septicization chamber. This type of tank was worked well at many places, but at others there have been occasions when complications arose from odors, apparently explainable by the type of bacterial decomposition which had gotten under way in the sewage solids before arrival at the plant. Acid fermentation and overflow at the gas vents have proved bothersome at some places. At Plainfield this complication was relieved by the installation of fine screens which remove the coarser solids at about the same unit expense on a dry basis as is done in the tanks. There has never been obtained from sludge withdrawn at several plants, receiving the flow of separate sewers, as low water content as found in the earlier plants of this type in the Essen district. In fact the average water content of the Plainfield sludge is as high as 93 to 94 per cent, thus calling for about twice as large sludge digestion chambers as were figured on a few years ago. Where tanks of relatively great depth, as this type usually calls for, would encounter wet excavation or rock in their construction there is also substantial reason for considering the single-story tank.

Single story tanks are favored at this time by quite a number of engineers. Some of them have always adhered to their preference for the old single-story septic tank for small or moderate sized installations. The use of Dorr thickeners to concentrate the sludge and facilitate its removal from single-story tanks has been favored at several places where tests have been made. At Grand Rapids, Mich., trade wastes of a fibrous character allowed the deposit or sludge in single-story radial--flow tanks to assume such consistency that it became spadable as it was removed from a central sludge well. Whether this would be true of sludge of a finer texture as to the charatcer of its suspended particles is quite debatable. One of the advantages of this type of clarification arrangement is that it allows an undecomposed sludge to be dried without offense on drying beds, according to Grand Rapids data. The sludge coming from the sewage of different cities varies widely and it is hardly necessary to state that the experiences at one locality are not necessarily a criterion as to accomplishments to be expected elsewhere.

SINGLE-STORY TANKS IN ROTATION.

Single-story tanks were used at the army camps partly for reasons of economy and partly in order to allow camps to be constructed quickly. The tanks at several camps gave satisfactory results as to freedom from odors and as to the degree of clarification accomplished. But at many, and perhaps most, of the camps sludge digestion was not satisfactory due to an overtaxing of their capacity, to the amount of grease found in the sewage, and to the acid fermentation persisted at many of the plants.

In the summer of 1918 the writer in conjunction with Metcalf & Eddy served as Consulting Engineer on betterments at the army camp sewage disposal plants. Investigations and reports were made looking to not only the elimination of grease in the army kitchens, the reduction of useless quantity of sewage flow, but also to a substantial enlargement of the tanks making them 3½ to 4 times as great per person served as was originally projected. As a part of this enlarged tanks program was the suggestion of using the tanks in rotation so that when one tank began to release suspended solids in the effluent it could be put out of service for a number of months until the suspended matter became digested, after which it would be cleaned and again put into service. Thus one tank after another would be used in rotation first as a sedimentation tank and then as a digestion tank.

When these single-story tanks are provided with a tight cover and are used in this way the indications are that there would be less likelihood of odor than with either the two-story type of tank or the single-story type used as in earlier years for the joint purpose of sedimentation and sludge digestion. This program of using tanks in rotation was developed at Plainfield, N. J., in 1910 and 1911 as recorded in the technical journals at that time. The local plant, however, was not large enough to permit these arrangements to be carried out satisfactorily. Better results were obtained at Mount Vernon, N. Y., and particularly at Washington, Pa. Undoubtedly this arrangement has much to commend it when the method is applied so that the sewage solids may be retained in the tank for five or six months for digestion. The cost of single-story tanks of moderate depth for this style of operation is quite likely to be less than that of two-story tanks in some localities. The general economy is not great and with very dilute sewage they might be more expensive than other types of tanks.

OXIDIZING ARRANGEMENTS.

From what has been said above, the dilution method for the dispersion and oxization of soluble and non-settling organic matter, so as to prevent putrefactive nuisances, has a better standing today in this country than ever before. For relatively small projects where tracts of porous land, as in New England, are available, intermittent sand filters are still worthy of careful consideration. Contact beds are preferable for some plants where isolated sites are not available and where pumping is unusually expensive and can be avoided with this type but not by others.

The two main methods now being considered for sizeable projects are trickling filters and the activated sludge method.

TRICKLING FILTERS.

Trickling filters enjoy a better reputation today than ever before. They have been in service at Reading and Columbus and other places for ten or twelve years

without need for removing and cleaning the filtering material. The fly question can be safely handled by submerging the larvae by flooding the filter beds from time to time as was demonstrated at Plainfield, N. J., under the direction of the State Entomologist. This flooding of the beds also provides a means for removing accumulated films of organic matter from the stone, thus making more uniform the unloading operations as compared with plants which unload solely through natural agencies. Load factors for trickling filters are well established and there has been little to change in recent types of designs. Mention may be made of the apparent lack of necessity for installing pipe galleries and valve control of distributing influent lines to the extent considered some years ago. The reason is that clogging of the beds or false bottom has not been a factor. Means of efficient distribution of liquid from the spray nozzles is probably better appreciated than formerly.

ACTIVATED SLUDGE.

For decolloiding sewage, that is, for removing the non-settling solids so that after sedimentation a clear non-putrescible effluent is obtained, the activated sludge process has also a better status today than ever before. It has not made the advances as regards sludge recovery that were anticipated a few years ago. This is partly due to difficulties and expense of dewatering the sludge and partly due to falling prices of fertilizers and the increased cost of transportation of the product to be used as a filler at localities where the fertilizing trade has its centers.

The process has undoubtedly a different rating in different cities due to the varying character of the suspended matter, the local cost of power and opportunities for disposal of sludge. As a means of avoiding the expense of long outfall sewers in some localities the process is worthy of special attention. Present tendencies are to rate this project as more suitable for large than for small plants as sludge recovery is not worth attempting for the latter. There are some localities where the method may be suitable and advisable notwithstanding its relatively high operating expense in order to avoid the cost and difficulty of establishing a plant of another type at a desirable isolated site, far removed from where a plant of this type may be built. As an oxidizing and decolloiding method it is entitled to high rating in point of reliability. At times the activation of the sludge seems to deteriorate, thus suggesting the wisdom of having reaerating tanks from which to replenish sludge that has been depleted in its biological activities.

Recently I had occasion at Lima, Ohio, to reconsider the adoption of this type of plant, recommended in 1917 for serving about 60,000 population. The high local power costs, existence of a site available for either activated sludge or trickling filters, and the improbability of getting substantial sums from the sale of sludge led to a change in recommendation from the activated sludge method to a trickling filter plant preceded by fine screens. The latter are much cheaper to operate, although of greater first cost, and this is considered an item of importance in some Ohio cities, where operating expenses must be kept within fixed limits and where bond interest is not so closely limited for sanitary improvements ordered by the State Department of Health under the Bense Act.

As regards the amount of sludge recovery in the activated sludge process, available data are not very precise for indicating the quantity of suspended solids (sludge) per thousand population per day or year. An addition to the quantity of ordinary suspended matter should be made for non-settling solids or colloids precipitated by

this process and deductions made for the losses in suspended solids incident to the wet combustion of colloid matters in the aerating tanks. How such additions and subtractions compare is not accurately known and local conditions are doubtless of great significance, both as to the sewage itself and details of plant operation.

Perhaps a word should be said with respect to the electrolytic devices of treatment as compared with the information available at Louisville and elsewhere in earlier years. A plant of this type has been in service for some months at Phillipsburg, N. J., and other plant is about completed to serve a small portion of the city of Allentown, Pa. The sewage of the former city is unusually weak and data are needed for showing the cost of the process for making a sewage of normal strength non-putrescible.

The same is true of the sludge disposal aspect. A paper in the Journal of the Franklin Institute, describing tests at Easton, did not meet with much favor from many of those of practical experience in this field and who are waiting to see reliable cost data from Phillipsburg, Allentown or elsewhere.

TREATMENT AND DISPOSAL OF SEWAGE SOLIDS.

From earliest times this phase has presented the main difficulty and expense for large undertakings in the sewage disposal field, distant from the seacoast. It is still true today notwithstanding that our knowledge has increased materially. Experience with one so-called cure-all after another has made sanitary engineers more cautious than ever before. As regards recovery for a fertilizer it is apparent from what has been said above that there is no royal road to success along that line, although some sizeable cities may do very well in preparing the sludge for use as fertilizer. Briefly, different forms in which sewage solids are encountered have been shown experiences as follows:

SCREENINGS.

Screenings show 80 to 85 per cent of water depending upon the extent to which they are drained. At the Plainfield, N. J., plant they are removed by a tractor in a manure spreader from which they are distributed on cultivated fields and plowed in at frequent intervals. At Washington, Pa., they are wheeled to a dump, the surface of which is sprinkled with chloride of lime as required and the screenings are taken from the dump at the convenience of local farmers just prior to plowing periods. At Rochester the screenings are taken to a dump and covered with the deposits removed from the grit chamber. At several plants the screenings are composted and at a number of others they are burned either under boilers at power plants or else in specially designed crematories. At most plants there is comparatively little fertilizer value in screenings. There is enough organic matter, however to give trouble from flies and odors unless they are handled in a prompt sanitary manner under intelligent direction.

PLAIN SEDIMENTATION SLUDGE.

Drying on sludge beds seems to be satisfactory according to experiences at Grand Rapids where Dorr thickeners have been employed and where spadeable sludge has been obtained from the local sewage with its fibrous trade wastes. Drying on open beds of ordinary sludge from plain sedimentation tanks has given tolerable results at a number of places but it requires more isolation than is available

at many plants. Separate digestion of sludge in independent tanks can be negotiated but, like digestion in single-story or two-story tanks, it is not entirely free of odor or of difficulties in getting complete digestion of the organic matters. Sludge digestion tanks where one of a series is used after another in rotation first as a settling tank and then as a digestion tank, has decided merits although it needs substantial factors of safety as to size and number of tanks according to experiences at Washington, Pa. Probably the latter experiences are more favorable than would be the case with sewage from which the grosser suspended matters had not been removed by relatively fine screens. The latter tend to lessen materially the amount of scum which as mixed with grease decomposes slowly to an inodorous mass. When the latter result is attained it makes feasible the disposal of such sludge on drying beds.

SLUDGE DRYING BEDS.

Sludge drying beds are now being provided at two or three times the size called for in designs of a few years ago. This is particularly true of beds receiving the sludge from Imhoff tanks. This is occasioned in part by a greater water content of Imhoff sludge than was previously expected and is partly due to a more frequent appearance of substantial rainfall than is the case in Europe from whence came earlier records of experiences.

CENTRIFUGING.

Experiences at Frankfort and Hanover, in Germany, show that the sludge from plain settling tanks can be reduced to a spadeable condition by these mechanical appliances in a satisfactory and economical manner. There are no such devices of this type in this country at present, except for experimental purposes. It is expected that soon data will be available from Milwaukee where Mr. Hatton has procured during the past seven years so many data of practical importance.

DISPOSAL OF SEWAGE SOLIDS.

Some sewage sludge has been sent to lagoons and much has no doubt been discharged into neighboring bodies of water at high flow. Where these arrangements have not been negotiable sludge drying beds have caused the accumulation of substantial quantities of air-dried sludge upon sludge dumps. Where public authorities have themselves used this sludge for farming operations there has been quite a tendency as a result of such demonstration for farmers in the neighborhood at intervals to cart away solids, but there has not been substantial revenue derived therefrom. In other words it has been a case of getting rid of the sludge at least expense.

SLUDGE DRYING FOR FERTILIZER USE.

During the war air-dried sludge at the Baltimore plant was put through a rotary drier to reduce its moisture to about 10 per cent and thus prepare it for use as a filler by the fertilizer trade. Falling prices of fertilizer put that operation out of business some little time ago. This sludge had been previously septicized and contained only about two per cent of ammonia for which the contractor operating the drying machine paid the city 81 cents per ton, calculated on a basis of 15 per cent water content. Activated sludge is much richer than this, usually containing 4 to 5 per cent ammonia, due partly to the absence of septicization and partly to the precipitated colloids.

Recovery of sewage sludge for fertilizer use in connection with activated sludge plants ,or from trickling filters and final settling tanks operated with a view to producing sludge for fertilizer use, has not progressed beyond the experimental stage. Operations with activated sludge have been carefully conducted for some time at Milawukee, Chicago and more recently at Houston, Texas. Dewatering to a spadeable condition such as is desirable before putting sludge into a drying machine has been found to be difficult and expensive owing to the sticky nature of the very dilute activated sludge. Drying operations are predicated largely upon the experiences of garbage reduction plants and of the packing industry although the drier at Baltimore was operated for quite a period. Grease is a complicating factor and some sludge may require degreasing. Salability of the grease is doubtful for most sewages. Control of odors is undoubtedly an important item in sludge drying but with care can apparently be managed. Mention should be made of the work of the electro-chemists and of other steps at Milwaukee for bringing sludge into a condition where it will respond most readily to dewatering operations.

In closing it may be stated that information has been moving forward at a slow rate and the commercial aspects as regards general practice remains for the future to reveal. Recent experiences of garbage reduction works in disposing of tankage are not promising. However, large cities such as Chicago and Milwaukee can well afford to proceed with their present plans and investigations; and the price and need of fertilizer in the Los Angeles District led the Sewage Disposal Commission for that city recently to recommend the installation of a 2.5 million gallon activated sludge plant for demonstration purposes.

PROPOSED INVESTIGATIONS IN STRUCTURAL ENGINEERING

W. M. Wilson*

Presented May 9, 1921.

Structural steel design is largely a mathematical process and is looked upon by many structural engineers as an exact science, nevertheless the mathematic processes are often based upon assumptions which have never been verified, and many of the mathematical operations are nothing more than the solution of empirical equations. Too often these equations lack experimental verification. The changes which are made in specifications from time to time, indicate that the concensus of opinion relative to the fundamental assumptions and relative to the empirical relationships are continually changing. Structural Engineering is, therefore, not a fixed science, but a science which is rapidly developing.

A study of the discussions which accompany changes in specifications indicate that, whereas, some revisions are the direct and inevitable result of additional scientifically established facts, other revisions grow out of a change in what is nothing more nor less than the opinion of the structural engineers. Although this opinion may be entertained by the leaders in the profession, as long as scientific confirmation is lacking, the opinion is liable to further change with additional experience. It is therefore highly important that all basic assumptions and all empirical relationships be checked by scientific experimental work.

It is believed that certain problems in structural engineering should receive further experimental study. In presenting these problems the position is taken, not that our present practice is necessarily wrong, but that we have not sufficient knowledge to justify us in forming a final and definite conclusion.

The following are a few of the many problems which affect either the cost or the safety of structures.

I. EFFECT OF REVERSED STRESSES ON RIVETED JOINTS.

Tests of riveted joints show that the resistance to slip is due to friction between the plates induced by the tension in the rivets. Moreover this slip, an inelastic strain, occurs at stresses considerably below the stresses for which connections are designed. These statements being true, if a stress on a connection acts in one direction there will be a slip in that direction; and if the stress is reversed, the slip is in the reversed direction. By repeating the cycle, the repeated slip will result in wear which relieves the tension on the rivet and thus reduces the resistance to slip. Therefore, a large number of reversals may result in an amount of wear which will permit a small stress to produce a large slip.

That the action outlined does take place is evidenced by the fact that connections of members subjected to reversed stresses do work loose. This has been observed in a number of structures.

To further establish the action outlined, a few tests were made to determine the effect of repeatedly reversed stresses (unpublished tests made at the Engineering Experiment Station of the University of Illinois by W. M. Wilson). These tests show that connections subjected to reversed stresses, if designed in strict accordance with our present specifications, may be expected to develop loose rivets. This being

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true, changes in the usual specifications should be considered. But before the specifications can be changed intelligently, more complete knowledge relative to the behavior of riveted connections subjected to reversed stresses is needed. Experimental data are desired to answer the following questions:

1. What is the proper unit stress to be used in designing a rivet subjected to reversed stresses?

2. What is the relative value, as judged by their ability to resist reversed stresses, of rivets driven by different methods?

3. Is it possible to develop a method of driving which will increase the ability of rivets to resist reversed stresses?

Because of the increase in the weight of rolling stock, railroads are compelled to subject their bridges to stresses considerably greater than the stresses for which the bridges were designed. Following the recommendations of the American Railway Engineering Association, the stress in tension for rating old bridges made of open-hearth structural steel is 26,000 lbs. per sq. in., while the corresponding stress in shear on rivets is 22,000 lbs. per sq. in. In both cases the allowable stresses are reduced if the stresses are reversed; the reduced stress for tension on steel is 17,333 lbs. per sq. in., and for shear on the rivets is 11,000 lbs. per sq. in., if the reversal is from a stress in one direction to an equal stress in the opposite direction.

Fatigue of metal tests indicate that a tensile stress in steel considerably greater than 17,333 lbs. per sq. in., can be reversed millions of times without breaking the metal, whereas, tests indicate that if a shear on rivets of 1,000 lbs. per sq. in., in reversed only a few thousand times, the rivets are loosened. It therefore seems probable that overloading bridges will injure the bridge, not by injuring the metal, but by loosening the rivets. This being true, an extended investigation of the behavior of riveted joints subjected to reversed stresses assumes unusual importance.

II. A COMPARISON OF VARIOUS TYPES OF WIND BRACING FOR STEEL SKELETON BUILDINGS.

The usual method of stiffening the frame of a steel-skeleton building so that it will resist wind pressure, is to make the joints connecting the girders and columns rigid, so that they can resist moment. Two types of connections are in general use. With one type, in order to erect the girders, it is necessary to slip the gusset plate, a part of the column, between the flange angles of the girder. As this operation takes place high in the air, the erection is quite difficult. With the other type, erection is accomplished by swinging the girder between two adjacent columns, and riveting the outstanding legs of the connection angles to the outstanding legs of the column, a very simple process. In spite of the fact that the first type is much harder to erect than the second, the former is replacing the latter, as it is believed to be more rigid. A very limited number of tests (Bulletin No. 104, Engineering Experiment Station, University of Illinois, by Wilson and Moore) show that there is but little difference between the rigidities of the two types of connections; and that, if there is any difference, the second is slightly stiffer and therefore better than the connection of the first type. It is desirable to determine definitely the relative merits of these two, and also of other types of connections.

III. DISTRIBUTION OF THE STRESSES AMONG THE RIVETS OF LARGE GUSSET PLATES.

In designing a riveted connection which is not subjected to moment, it is assumed that the total stress on the connection is equally distributed among the

rivets. Gusset plates are usually much wider than the members from which they receive stress. Under these circumstances, it seems probable that the stress in the rivets in a line with the axis of the member may be greater than in the rivets near the edges of the gusset plate.

In riveted joints, as in elastic material, the stress is approximately proportional to the strain. Because of the difference in stresses in the gusset plate and in the member, the slip, the relative motion between the two, may not be the same at all points. As the stress depends upon the slip, a variation in the slip will cause an uneven distribution of the stress among the rivets.

A limited number of tests by Cyril Batho (Journal Franklin Institute, Vol. 182, page 553) indicate that the stress on a joint is not evenly distributed among the rivets. The maximum stress will, therefore, be greater than the total stress divided by the total number of rivets, as now assumed. A thorough investigation of the distribution of stress among rivets is desirable.

IV. EFFECT OF THE RESTRAINING ACTION OF THE END CONNECTIONS UPON THE STRINGERS OF THROUGH TRUSS BRIDGES.

The stringers of through trusses are connected to the floor beams by means of connection-angles which run the full depth of the stringers. Tests show (Bulletin No. 104, Engineering Experiment Station, University of Illinois, by Wilson and Moore that these connections are quite rigid. This being true, two stringers meeting end to end act as a continuous girder. While this action reduces the moment at the center of the stringer, it also produces a large, suddenly applied moment on the stringer connection. And the stringer connection is not designed to take moment. It is desirable to determine the moment on the connection-angles and, if it is found to be dangerous, to devise alternate possibilities of design.

V. EFFECT OF NOT FITTING THE ENDS OF INTERMEDIATE STIFFNESS OF PLATE GIRDERS TO THE OUTSTANDING LEGS OF THE FLANGE ANGLES.

Stiffeners of plate girders are fitted carefully to the flange angles. This involves grinding the ends of the stiffener angles to exact length and shape, and involves either the use of thick fills or of crimping the angles. Taken altogether this fitting adds materially to the cost of the girder.

The function of intermediate stiffeners is to prevent the web from buckling. The stiffener does not in any sense transfer stress to or from the flange angles. It would therefore seem that the requirement that the ends of intermediate stiffeners be ground to fit the outstanding legs of the flange angles is without a rational basis. It is desirable to make tests to verify this statement.

VI. MATHEMATICAL STUDY OF SECONDARY STRESSES.

The exact theoretical determination of secondary stresses is a very laborious process. This is true to such an extent that secondary stresses are neglected except for very important structures, in spite of the fact that it is known that, theoretically at least, secondary stresses are often almost as great as primary stresses. It is desirable to make a careful study of secondary stresses with the idea in mind of establishing empirical rules for determining secondary stresses. These rules should be accu-

rate enough for purposes of design and should also be so short that they will be used by the practicing engineer. Such rules have been established for wind stresses in steel skeleton buildings (Bulletin No. 80, Engineering Experiment Station, by Wilson and Money) and it should be possible to establish them for secondary stresses in trusses.

VII. EXPERIMENTAL STUDY OF SECONDARY STRESSES.

To a large extent, secondary stresses have been neglected by practicing engineers. The engineer has justified his action by the statement that secondary stresses are small, or that the determination of secondary stresses is based upon false assumptions, and that large secondary stresses do not exist.

Inasmuch as computed secondary stresses are often very large, they should not be neglected, if they actually exist; and if they do not exist, the ghost should be laid. A limited number of tests show that secondary stresses do exist, and that the measured and computed stresses agree quite well. Tests by Parcel and Maney (Engineering News-Record, December 9, 1920, p. 1116), show a secondary stress equal to 85 per cent of the primary stress at a time when the primary stress is a maximum. Further experimental data are desirable.

VIII. THE EFFECT OF THE ELONGATION AND COMPRESSION OF THE BOTTOM CHORD UPON STRESSES IN THE FLOOR SYSTEM OF A THROUGH TRUSS BRIDGE.

The stress in the bottom chord of a truss is a maximum at all points when the whole span is loaded. This being true the entire bottom chord can be subjected to a maximum stress at the same time. The elongation due to live load and impact stresses from the center to the end of a 200 ft. truss is approximately one-half inch. If therefore the floor system is erected with no live load on the span, the passing of a full live load over the bridge will produce a horizontal deflection in the end floor beams of one-half inch, a strain that is neglected in the design of the bridge. The bending of a floor beam also produces a horizontal shearing stress on the floor beam connection angles which is not considered in the design. Strain-gage measurements taken on bridges under actual conditions of service disclosed stresses very much in excess of the stresses produces by the vertical load on the floor beams alone.

IX. WHY A MORE EXACT KNOWLEDGE OF THE BEHAVIOR OF STRUCTURES IS DESIRABLE.

Research work necessary to answer the questions which have been raised is expensive. Moreover, a more exact analysis of stresses in structures would probably require better trained designers and would probably require that more time be spent on the design of structures than is now customary. Both of these changes increase the cost of a design. The question is often raised, why is it necessary to incur this expense for research since our present designs are proving satisfactory in service? To accept the line of reasoning implied by this question is to accept the design of the ancients as the acme of structural science as these structures have stood through the centuries. To accept the line of reasoning implied by this question is also to eliminate economy as a controlling factor in an engineer's work.

All structures are designed with a factor of safety. That is, every member is made strong enough to arry a load greater than any load to which it is likely to be

subjected. The magnitude of this factor of safety varies through a wide range. The fact that a structure has not failed in service is proof, not that the design is properly balanced, but that in trying to provide a factor of safety of from 2 to 5 the designer has succeeded in providing a factor of safety of at least one in each and every member.

If a designer were to specify a tension member having a cross-sectional area of 20 sq. in. at one end and a cross-sectional area of 20 sq. in. at the other end the design would be ludicrous. Such an evident lack of balance in the design would be ludicrous. Yet the only offense which the designer has committed has been to provide a factor of safety of three at one point and a factor of safety of two at another point in the same structure.

Tension members are usually designed for a primary unit stress of 16,000 lbs. per sq. in. Some tension members are subjected to practically no secondary stress while others have secondary stresses equal to 50 per cent of the primary stresses when the primary stresses are a maximum. This being true, the member which is not subjected to secondary stresses has a factor of safety 50 per cent greater than the factor of safety in the member subjected to the secondary stresses. That is, the neglect of secondary stresses results in structures which are as badly unbalanced in design as a tension member having a sectional area 50 per cent greater at one end than at the other. There is, however, this difference. The fact that the design is unbalanced is self evident in the one case, but is concealed by a misleading statement of the stresses in the other case. It is like two thieves of whom one is caught while the other escapes. One is counted a thief and the other is not, but they are both equally guilty.

The object of the designer should be to produce a balanced design. That is, all members of equal strategic value should have equal factors of safety. If all but one of a number of members of equal importance have a factor of safety of three, while the one member has a factor of safety of two, the material in the others in excess of that necessary to give than a factor of safety of two is wasted. And this waste is chargeable to poor design.

I have heard the statement made that so long as engineers receive as a fee a certain per cent of the cost of the structure they will not reduce the cost at increased expense to themselves by making more careful designs. This position is comparable to the position taken by a physician who would advocate halting all medical research, as more perfect knowledge would result in better health for the community and less fees for the doctor.

Engineers bemoan the fact that their profession is so unremunerative. Yet they continue to design with a handbook and to a great extent refuse to give special problems the study which they deserve. The very fact that they accept handbook design makes it necessary for them to compete with handbook artists who do not understand the principles involved in the formulas which they use, and who make no pretense at having a professional training. Many of these handbook designers are not professional men in any sense of the word. They should be classed as mechanics. Yet so long as we are content with handbook designs we will have to compete with the handbook artist.

Many designers do not realize the source of the information which handbooks contain nor do they realize how the requirements contained in specifications are

established. The well founded equations and requirements of the specifications are based upon research work of the past. Methods of design which are still in a state of flux require research work for their final determination.

I believe that what is usually known as a factor of safety should be considered as the product of two factors, one a true factor of safety, and the other a factor of ignorance. The work of our scientists has made it possible to manufacture steel whose physical properties will not vary more than 5 to 10 per cent from the standard desired. This being true, if we have a steel whose elastic limit is 32,000 lbs. per sq. in. and whose ultimate strength is 64,000 lbs. per sq. in., it certainly would be safe to deliberately plan on subjecting this steel to a stress of 24,000 lbs. per sq. in., providing we were absolutely sure than 24,000 lbs. per sq. in. is the maximum stress to which the member will ever be subjected. The ratio $\frac{32{,}000}{24{,}000} = 1.33$ (or $\frac{64{,}000}{24{,}000} = 2.66$ if the factor is based upon the ultimate strength instead of upon the elastic limit)is a true factor of safety. But because we are not sure just what load the member will be required to carry, we design for a stress of 16,000 lbs. per sq. in. The factor $\frac{24{,}000}{16{,}000} = 1.5$ is not in the true sense a factor of safety, but is in reality a factor of ignorance. We are afraid that the stress which we believe will be 16,000 lbs. per sq. in., may be 24,000 lbs. per sq. in. This factor of ignorance is a measure of the amount by which the working stress is reduced and a measure of the amount of material wasted because of a lack of knowledge of the exact stress to which a member will be subjected.

The factor of ignorance covers a lack of knowledge of the exact value of the maximum load to which the structure is subjected, and also covers our inability or our unwillingness, to make an exact analysis of the stresses due to a given load. Ignorance as to the maximum value of the load in many cases cannot be eliminated; but ignorance as to the stress resulting from a given load can at least be reduced if not, in fact, entirely eliminated. The elimination of one contributing part of the factor of ignorance should justify a reduction in the factor itself, and should justify the use of higher working stresses than are now permitted.

For the benefit of those who object to increasing our present working stresses where more exact analyses are used, let me call attention to the fact that scientists who are experienced in testing materials find that it is impossible to injure structural steel with a tensile stress of 24,000 lbs. per sq. in. In the few cases where steel structures have failed, the failure has not been because the true factor of safety was too small, but because the factor of ignorance was too small. In fact, in the case of most of the failures, the ignorance on the part of the designer was so colossal that no factor could be depended upon to offset its effect. I believe that more care in stress analysis and increased knowledge of the behavior of structures subjected to load will promote economy and safety simultaneously.

X. HOW STRUCTURAL RESEARCH CAN BE PROMOTED.

There are two interested parties in every contract for a steel structure, the manufacturer who furnishes the material and the owner who pays the bill. The manufacturer wants the structure designed so that it will be easy to manufacture and, if it is a lump sum contract, he is interested in light weights. But he knows

that if the structure fails his reputation will suffer. The owner having once signed the contract wants the best bridge that he can get. But he knows that if his specifications are unreasonable he will have to pay an exorbitant price. So that while the interests of the two parties at first glance seem to conflict, they really are in harmony. Both want the lightest possible bridge that will safely carry the load. Both will be financially benefited by the development of this ideal structure.

Although manufacturers and owners will both be benefited by the development of an ideal design they are both human, and neither is always willing to believe that changes suggested by the other are for their mutual benefit. The owner is likely to question innovations in shop practice, believing them to be the product of a desire to cut shop costs rather than to increase strength. Likewise the manufacturer may consider that changes suggested by the owner, increase the cost more than they increase the quality.

It therefore seems apparent that any research work which might result in changes in design or manufacture should be conducted by a disinterested party. This is necessary in order that the results may be accepted without prejudice by both parties. Furthermore, scientific investigations require long continued painstaking efforts. Both of these requirements point to our scientific organizations such as the Bureau of Standards and the Engineering Experiment Stations as the proper agents to undertake this work.

The scientific organizations have the men trained in scientific work and have much of the equipment, but they cannot undertake any extensive series of test because of a lack of funds. However, inasmuch as both the manufacturer and the owner will be benefited financially by the development of the design and manufacture of steel structures, it is not unreasonable to ask them to help the scientific organizations finance the investigations.

The railroads are and always will be in the market for steel structures. They probably have a greater interest in the development of structural engineering than any other single class of users. They are interested in more exact knowledge of the relative merits of various shop methods. Moreover, their interest is not scientific alone, but economic as well. If additional knowledge will give them as good bridges at less cost, or better bridges at the same cost, they are justified in spending money to gain this knowledge.

The knowledge to be gained by the suggested tests to determine the effect of reversed stresses on rivets, will, I am sure, help the railroads to keep their old bridges in service under the present increasing loads. This saving will exceed the cost of the research program necessary to obtain the knowledge required.

The manufacturers will also be financially benefited by the elimination of unnecessary shop refinements which add but little or nothing to the quality of the structure but which add materially to the cost of production.

I believe that it is possible to establish a scheme of co-operation whereby the manufacturers and the users of structural steel, especially the railroads, will cooperate with the scientific organizations of the country to the end that extensive research work in structural engineering can be undertaken. The part of the scientific institution will be to furnish the scientific staff, laboratories, and standard equipment, and to publish the results. The part of the manufactures and users of the structural steel wil be to furnish the material to be tested and to furnish money

to pay for special equipment and technical assistants. The engineering staffs of the commercial organizations will also be expected to consult with the scientific staffs in planning the investigations.

I believe that such a scheme of co-operation will be beneficial to all parties concerned.

Precedent for this co-operation has already been established at the University of Ilinois. The Engineering Experiment Station of the University is or has been a partner in the following investigations:

Investigation of Coal Mining in Illinois.

Investigation of the Manufacture of Gas from Illinois Coal.

Investigation of the Stresses in Railway Track.

Investigation of the Effect of the Size of Coal on Locomotive Performance.

Investigation of Warm Air Furnaces and Furnace Heating.

Investigation of the Fatigue Phenomena of Metals.

Investigation of the Viscosity and Electrical Conductivity of Glass.

Investigation of the Friction Losses and Power Requirements in the Proposed Ventilating System for the New York and New Jersey Vehicular Tunnel to be Constructed Under the Hudson River.

These co-operative tests have been financed from sources outside of the Engineering Experiment Station to the extent of approximately $340,000. And in every case the parties contributing the funds have felt that the value received exceeded the funds expended.

A similar program of co-operative research is desirable in structural engineering.

EXPLANATION OF CURVES

Written Discussion by R. F. JENSEN on Mr. C. F. Loweth's Paper, "Classification of Old Railway Bridges," published in Journal, Vol. XVVI. No. 6, June, 1921.

The accompanying curves are a means of determining graphically, the actual stress produced by engines, cars, etc., in weak details of bridges whose classification, (or rating as to carrying capacity) has already been figured. These curves serve to give quickly an answer to the frequent inquiries of operating officials as to what rolling stock may, or may not, be run over various lines and over the included bridges thereon; whether the rolling stock in question should be restricted in speed over certain bridges; and what such restrictions must be.

Most modern progressive railroads have today all their bridges classified systematically, and will, therefore, find this sheet of considerable value as a time and labor saver, as well as something accurate and therefore reliable. For their old bridges especially, are these curves important, since existing wrought iron structures call for more frequent investigations owing to steadily increasing engine and car total weights and wheel concentrations.

Assume we have a 60-foot girder span (it may be any type) in which, say, the girder flange section is the weakest detail, and which detail limits the bridge to certain locomotives only passing over it. Supposing this detail is rated (at 16,000 lbs. working stress) at about only E31, according to Cooper's loading. This is quite low and many modern heavy engines will be barred from the bridge, presumably. To see, however, just how this flange will be stressed under any particular engine we do this: Take the E31 detail in question, and using the E57 value shown on *sample calculation* sheet herewith,—(E57 equals the E31 plus 83 1-3% impact),—start at lower line of sheet at *E57* and follow the heavy line, (No. 1) taking into consideration the amount of dead load which the flange carries. The dead load is E5 in this case, the bridge having a typical track floor. (See calculations). (This is preliminary step, and position of said heavy line is fixed for the detail under consideration).

If now, we want quickly, an answer as to whether, *say engine* 4—8—2 (60) (see small engine sheet at top left) may safely run without speed restriction over the 60′ girder bridge; and what stress it will produce in the weak detail, namely, the flange section. Follow heavy line (No. 2) from 60′ span up to engine 4—8—2, over to full impact ($300/300 + L = 83$ 1-3%) down to and including dead load, and over to the left (diagonally) meeting the other heavy diagonal line (No. 1) from the bottom.

The *intersection* of these heavy lines is at stress line 26,500 lbs. This happens to fall beyond the 26,000 lb. limit, which would call for restricting the particular engine somewhat in speed. At an impact somewhat less than the full 83 1-3%, say 50%, the flange will be stressed under the allowed limit of 26,000 lbs., as noted by following the heavy dotted lines. The actual stress produced is 22,000 lbs., which is not excessive for a wrought iron detail.

On the aforementioned "Sample Calculation" sheet, attached hereto, is given the results for calculated rating of a typical flange section (from which the figures herein used were taken) worked out on the customarily used "Equivalent Uniform

Load" principle, utilizing the Cooper's E50 as a basis. Note, that these and other calculations to which I have referred are the ones tabulated by most railroads, and which they have available for general use.

All that is needed with these curves is (1) the E57 figure (Live Load plus Impact); (2) the Dead Load *E5*, and (3) the *impact percentage* (see underlined on "Sample Calculation" sheet). That in itself bespeaks the simplicity of the curves and method of application.

These curves *serve for any engine*, whether it be classified for moment, shear, or floorbeam reaction; and serves as well *for any kind of member* of whatever type of bridge. They are *also applicable to highway bridge* investigations under the heavy prevailing *truck and roller loads*.

Note what Mr. Loweth says in his article: "It is surprising to observe the extent to which it is generally assumed that the effect of various train loadings on bridges is in direct proportion to the aggregate weight of the locomotive and cars. This, of course, *is far from the truth and no approximation by such a method should be used to determine the safety of any bridge.*"

The object, therefore, is to show here, graphically, a quick, simple and accurate method for determining stress conditions existing under various loads, eliminating tedious and intricate figuring.

RAYMOND F. JENSEN.

COOPER'S E1 LOADING

SPAN	EQUIVALENT Moment	End Shear	UNIFORM LOAD F. R. Reactn.
10	112.5	150.0	100.0
12	111.1	145.9	97.1
16	109.4	132.7	88.8
20	103.1	125.0	82.0
25	97.6	113.6	75.6
30	91.2	105.1	71.9
40	82.0	94.2	69.6
50	76.1	87.1	
60	**72.3**	81.4	
70	69.8	78.9	
80	67.5	77.6	
90	66.0	76.2	
100	64.4	75.0	
125	63.9	71.8	
150	62.7	69.0	
175	61.0	66.0	
200	59.4	65.3	
250	56.2	62.6	

R. F. Jensen.

SAMPLE OF TYPICAL CALCULATION SHEET

Classification (or rating) of BRIDGE No. . . . .

Description: 60 Foot. (Any type.) Girder Span, ...etc.

MEMBERS

Stringers	Assume these to figure O. K.
(Details)	
Floorbeams	
(Details)	
Etc., Etc.	

GIRDERS.

Section of Flange (Weak detail, usually indicated here by some distinguishing mark)

Net flange are = 26.8 sq. ″

Effective depth = 57″, = 4.75′

Allowed moment at working stress = $26.8 \times 4.75 \times 16{,}000 = \frac{1}{8} wl^2 = \frac{1}{8} \times 60 \times 60 \times W$.

Therefore:—w = 4,500 lbs. (which is uniform load per foot producing the allowed moment, and takes into consideration Lice Load, Dead Load and Impact).

And E 1 = 72.3‡ (which represents 1-50 of the uniform load equivalent of Cooper's E 50 engine, and is used to rate the portions comprising the 4,500 lbs.)

Assume Dead Load of the floor per lineal foot at 360 lbs. Its classification would be 360 divided by the 72.3 or E5.†

The 4,500 lbs. total minu sthe 360 lb. floor would leave 4,140 lbs. for live load and impact. Then 4,140 divided by 72.3 equals E57.†

Now, since impact is 300/300 + L,* (or 83 1-3%)† we have the actual Live Load classification to be E 57 divided by 1.83 1-3 or E31. This is the rating at 16,000 lbs.

‡See table of E1 values for various spans.
†Use these figures on curves.
*Note:—300/300+L is arbitrary; any other formula, or curves, may be used for deciding on impact.

DISCUSSION

Hydraulics of the Chicago Sanitary District Main Channel.—Blanchard.
Journal of the Western Society of Engineers, Vol. XXV, No. 13, September 5, 1920, Page 471. Prof. Horace W. King (Written).

EXTRACT OF A LETTER TO THE AUTHOR.

"I am very much interested in the results of your investigation and believe that I can appreciate the labor involved in a careful and thorough undertaking of this kind. Your experiments are the best I know of relative to the effect, or rather lack of effect, of slope on the Chezy co-efficient.

"I have believed for some time that the Kutter formula would have been just as valuable and have given just as satisfactory results without the terms involving 'S' and from your paper it appears that it would be a better formula without such terms. So far as I know there is no basis for the 'S' terms excepting the Humphreys and Abbot experiments, which undoubtedly gave incorrect data.

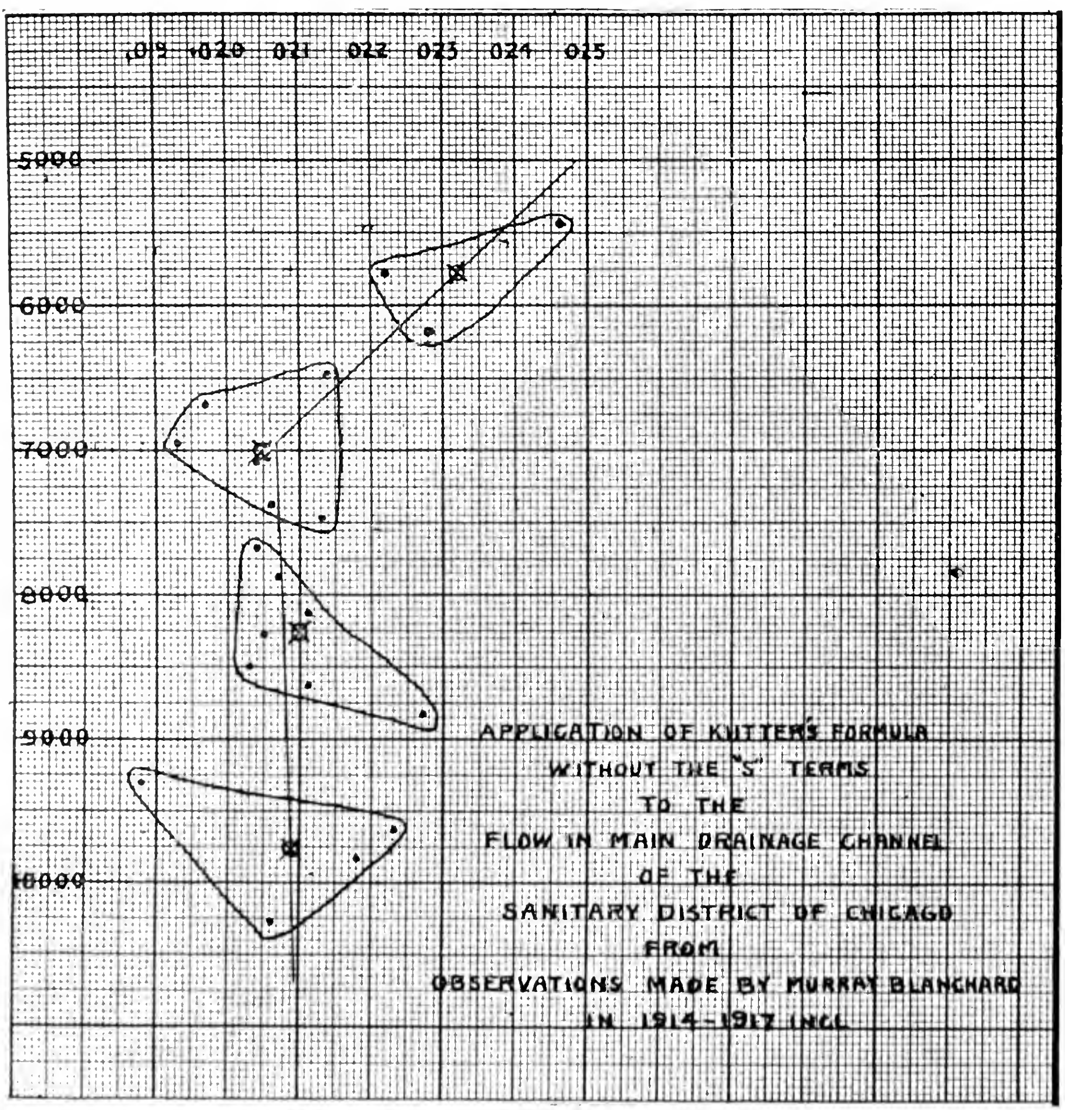

Fig. 27A.

"I have been sufficiently interested in this matter to compute values of 'n' by the Kutter formula, with 'S' terms omitted from your data which I have set opposite

your values in Table XVa. I have also plotted these values as shown on the accompanying diagram, Fig. 27a. It will be seen that the values of 'n' from this formula are more nearly constant than the values obtained from the regular Kutter formula. Values by the abbreviated formula also agree more closely with the Manning formula, being a little less than .021 where the Manning formula gives .022.

"It appears to me that the Kutter formula has been used satisfactorily for many years because in most cases, channels are constructed with slopes so great that the value of C is not greatly affected by the inclusion of the slope terms. This cumbersome correction has been used all of these years when the formula would really be better without it.

"I believe, however, that the Manning formula is an improvement over any form of the Kutter formula. Since the publication of the Handbook nothing has come up to shake my faith in the Manning formula, while a number of articles have been written and other information has come to me confirming it.

"I wish to congratulate you on having made so valuable a contribution to the science of hydraulics, and I wish to thank you for having made the results of your work accessible to me."

Table XVa.

Obs. No.	Q Observed	S	Vm	Rm	Kutter "n"	Kutter "n" Without "S" Terms	Manning "n"
76	5435	.000011	1.34	18.84	.038	.0246	.026
Mean	5435				.038	.0246	.026
7	5760	.000011	1.44	18.71	.036	.0226	.024
11	5750	.000010	1.46	18.58	.034	.0218	.023
Mean	5755				.035	.0222	.023
131	6180	.000012	1.50	19.11	.036	.0228	.024
Mean	6180				.036	.0228	.024
47	6534	.000010	1.58	19.24	.032	.0195	.021
81	6455	.000014	1.59	18.92	.035	.0233	.025
Mean	6595				.0335	.0214	.023
65	6750	.000010	1.62	19.38	.032	.0189	.021
86	6610	.000013	1.69	18.49	.032	.0205	.022
Mean	6680				.032	.0197	.0215
49	6900	.000010	1.65	19.35	.032	.0187	.021
129	6950	.000010	1.67	19.26	.032	.0184	.020
56	6985	.000013	1.70	19.09	.032	.0206	.022
121	6955	.000012	1.72	18.91	.032	.0174	.021
Mean	6950				.032	.0193	.021
60	7125	.000011	1.70	19.42	.031	.0189	.021
62	7095	.000012	1.71	19.22	.032	.0198	.022
55	7000	.000013	1.70	19.12	.032	.0208	.023
94	7130	.000015	1.79	18.61	.032	.0208	.023
85	7090	.000016	1.79	18.61	.032	.0218	.023
Mean	7090				.032	.0204	.022
147	7365	.000012	1.77	19.38	.030	.0190	.021
132	7380	.000013	1.77	19.30	.031	.0198	.022
122	7335	.000014	1.18	18.92	.030	.0200	.022
130	7390	.000015	1.82	18.92	.032	.0207	.022
20	7280	.000016	1.84	18.58	.032	.0212	.022

23	7425	.000017	1.90	18.44	.031	,0208	.023
108	7410	.000020	1.91	18.36	.032	.0225	.024
Mean	7370				.031	.0206	.022

TABLE XVa.—(Continued.)

Obs. No.	Q Observed	S	Vm	Rm	Kutter "n"	Kutter "n" Without "S" Terms	Manning "n"
165	7430	.000014	1.77	19.43	.032	.0208	.022
152	7580	.000012	1.82	19.30	.029	.0184	.020
137	7440	.000014	1.81	19.09	.031	.0200	.022
139	7440	.000014	1.81	19.12	.031	.0202	.022
24	7460	.000015	1.81	18.61	.030	.0206	.021
43	7560	.000017	1.92	18.58	.030	.0206	.022
19	7430	.000016	1.90	18.44	.030	.0200	.022
92	7430	.000019	1.90	18.38	.032	.0222	.024
111	7435	.000019	1.90	18.38	.032	.0222	.024
120	7515	.000021	1.94	18.28	.033	.0227	.024
84	7550	.000020	1.96	18.26	.032	.0219	.023
83	7500	.000021	1.95	18.17	.033	.0225	.024
1	7495	.000026	2.06	18.50	.032	.0244	.025
Mean	7480				.031	.0213	.023
153	7745	.000015	1.86	19.31	.031	.0204	.022
138	7680	.000014	1.88	19.07	.030	.0192	.021
142	7740	.000014	1.90	19.05	.030	.0191	.021
32	7655	.000015	1.90	18.80	.029	.0196	.021
110	7605	.000019	1.92	18.61	.032	.0220	.024
39	7770	.000018	1.96	18.60	.031	.0208	.023
18	7600	.000015	1.94	18.50	.028	.0187	.021
113	7780	.000021	2.00	18.34	.032	.0219	.024
88	7600	.000019	1.98	18.21	.030	.0208	.023
87	7605	.000020	1.98	18.17	.031	.0216	.024
Mean	7680				.031	.0204	.022
164	7805	.000014	1.86	19.46	.030	.0197	.022
163	7990	.000015	1.94	19.17	.030	.0193	.021
116	7840	.000020	1.97	18.62	.032	.0220	.024
40	7815	.000017	1.96	18.56	.030	.0202	.022
33	7925	.000019	2.02	18.50	.030	.0208	.022
126	7905	.000021	2.00	18.56	.031	.0222	.024
106	7840	.000020	2.00	18.45	.031	.0215	.023
35	7860	.000017	2.00	18.44	.029	.0195	.021
34	8095	.000021	2.12	18.15	.029	.0204	.022
101	7915	.000020	2.07	18.14	.029	.0204	.022
98	7820	.000022	2.04	18.13	.029	.0218	.024
Mean	7890				.030	.0207	.022

TABLE XVa.—(Concluded.)

Obs. No.	Q Observed	S	Vm	Rm	Kutter "n"	Kutter "n" Without "S" Terms	Manning "n"
144	8180	.000016	2.14	19.21	.027	.0179	.020
105	8140	.000020	2.07	18.51	.030	.0208	.022
127	8210	.000023	2.10	18.46	.031	.0220	.024
100	8080	.000019	2.08	18.38	.029	.0199	.022
107	8080	.000021	2.09	18.28	.030	.0208	.023
99	8105	.000021	2.10	18.24	.030	.0207	.020
96	8215	.000023	2.14	18.21	.030	.0214	.023
118	8005	.000023	2.10	18.12	.030	.0217	.023

115	8060	.000024	2.11	18.12	.031	.0221	.024
97	8095	.000024	2.12	18.07	.031	.0220	.024
117	8170	.000026	2.16	17.96	.031	.0224	.024
Mean	8120				.030	.0211	.023
156	2830	.000016	1.98	19.45	.030	.0198	.021
158	8360	.000017	2.02	19.45	.030	.0200	.022
160	8245	.000015	2.00	19.24	.029	.0187	.021
167	8200	.000022	2.07	18.60	.031	.0219	.024
44	8335	.000020	2.11	18.57	.029	.0203	.022
95	8260	.000021	2.11	18.47	.029	.0208	.023
124	8335	.000024	2.15	18.28	.030	.0217	.023
Mean	8280				.030	.0205	.022
159	8470	.000017	2.00	19.52	.030	.0202	.022
155	8545	.000018	2.03	19.45	.030	.0206	.023
149	8545	.000019	2.10	18.96	.029	.0200	.022
102	8500	.000023	2.21	18.18	.029	.0205	.022
Mean	8500				.0295	.0203	.022
150	8630	.000019	2.10	18.96	.029	.0200	.022
168	8630	.000025	2.17	18.62	.031	.0223	.024
Mean	8630				.030	.0211	.023
166	8845	.000032	2.36	17.81	.030	.0227	.024
Mean	8845				.030	.0227	.024
157	9300	.000018	2.20	19.59	.028	.0188	.021
Mean	9300				.028	.0188	.021
72	9615	.000042	2.71	17.13	.028	.0221	.024
74	9675	.000045	2.75	17.03	.028	.0226	.023
Mean	9645				.028	.0223	.023
163	9810	.000034	2.56	18.13	.028	.0218	.023
Mean	9810				.028	.0216	.023
162	10395	.000035	2.70	18.24	.027	.0209	.023
148	10280	.000034	2.71	18.02	.026	.0203	.022
Mean	10290				.0265	.0206	.0225

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TECHNICAL PAPERS

THE ORGANIZATION OF RESEARCH IN A DEMOCRACY

By R. A. Millikan*, Ph. D., Sc. D.

Presented June 8, 1921, at the Annual Dinner of the Western Society.

Despite the fact that I am not known as an engineer, I claim to be one. I cannot build a bridge. I am not a bridge engineer. I am not a railroad engineer, or a civil engineer, but I am a new kind of engineer—an atomic engineer, or if you want, an electron engineer. That is a kind of engineer that you are going to hear from in the next twenty years. You have been hearing of it in the last twenty years. I am simply saying, not as a boast, that this is a field which is opening to the engineering world in a way which you never dreamed a few years ago.

I went to a famous Physical Laboratory, in 1912, and the director said, "What in the world are you and Richardson fooling with those therm-ionic devices for? There is nothing in that field which is particularly interesting or important." That was in 1921. Three years from that time you were telegraphing across the continent by means of therm-ionic devices. Within four or five years of that time you were transforming power by means of therm-ionic devices. At the present time, when you telephone from New York to Chicago, your message is repeated four times—between New York and San Francisco twenty times—by a repeater, which does not miss an inflection. As you talk back and forth you hear each other just as distinctly as though you are talking across the street.

Those are some of the things which have been accomplished by the therm-ionic valve. The monetary values of those little studies which up to 1911 were exclusively the property of the man who was not called an engineer at all, the physicist in his laboratory, who had been studying them merely for the sake of finding how Nature worked; the monetary values are in the millions, and will soon be in the hundreds of millions. I wonder if you are aware that between Chicago and New York, all the old transmission lines that cost them such a mint of money at first, have now been pulled out and replaced by simple circuits equipped with tube amplifiers. When you realize what has happened in the last nine years, you begin to see that there is something outside of the established standardized engineering, that is so important that every engineer should begin to pay attention to it.

I am not going to talk tonight about the value of research. At least, I am not going to now. You are a body of pretty intelligent men and women, and I will

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take it for granted that you know of its value. I am not going to keep you very long either. But I am going to discuss quite briefly the fundamental problem of the mode by which a country like this can probably develop most effectively. Our scientific age is a new thing. It is a hundred years old. It is changing at a stupendous rate, as you know. It is going to change at a more stupendous rate. Whether we keep at the front of the line or not, will depend largely, almost wholly, upon how intelligent we are in fostering the spirit of investigation and the application of the results of the investigation quickly to our industrial processes.

There are only two ways in which a country can organize itself for that sort of thing. One is the way which is characteristic, and which has been characteristic of the whole development of German science and engineering; namely, through central control. That central control may be through government or it may be through the gaining of control, centralized control, by some private organization. I think that that method is one which does not adapt itself well to the genius of Anglo-Saxon civilization. That is not the way by which the triumphs of the Anglo-Saxon have in the past brought about. They have been brought about by individual competitive enterprise and not by governmental or centralized control.

And yet something has to be done. The easiest thing to do is to say "let the government do it," as Germany did. That is being done to quite a large extent now in other countries. Great Britain, even more democratic than we are, is establishing its governmental central laboratory. Canada is just now establishing a central research laboratory. Japan has within the last few years established an imperial research laboratory for engineering research, and for the application of science to industry.

That is not, however, the way in which such organization, as has yet been made in this country, has been brought about. The reason has been that those who have been instrumental in that organization have taken advice from some of our most far-seeing men like Mr. Elihu Root. He has been one of those who has been very influential in shaping the present development of the endeavor to organize research activities in a national way. Mr. Root's advice from the start has been,—not to depend upon governmental initiative or upon governmental control in any way,—but to organize in such a way that you will have a voluntary association of the multifarious research agencies which exist now and which are going to exist throughout the country.

First, I am going to give you a very brief outline of what the present situation is, as I see it. Then, we will come to some of the more fundamental things afterward.

The only national organization that has yet been developed which has the wholly research motive is the National Research Council. The National Research Council has not endeavored to conduct research or to get large funds for the conduct of research. There is, however, the possibility of correlating and effecting interchange between groups by using the committee method, by getting different groups studying the problem to see where the unexplored fields are, and where the necessity for attack is, then finding existing agencies, or, if necessary, creating new agencies for taking care of the need. The National Research Council has felt that the method best adapted to a democracy like ours was one in which its own activities are confined pretty largely to the job of promoting research in an effective though unpretentious way. "The National Research Council is a co-operative organization

of the scientific men of America, including also a representation of men of affairs and business interested in industry and engineering and in the fundamental or 'pure' sciences, on which the "applied' science used in these activities depends. The Council enjoys the formal recognition and active co-operation of most of the major scientific and technical societies of the country, its membership being composed in large part of appointed representatives of these societies. Its essential purpose is the promotion of research in the physical and biological sciences and the encouragement of the application and dissemination of scientific knowledge for the benefit of the Nation."

"The Council is composed of a series of major divisions. When you see how large the Council's ramifications are you will see what a tremendous job there is to be done. One group of seven divisions of a science and technology representing, respectively, (1) physics, mathematics and astronomy, (2) chemistry and chemical technology, (3) psychology and anthropology, (4) geology and geography, (5) biology and agriculture, (6) the medical sciences, and (7) engineering. Another group of six divisions of general relations, representing foreign relations; federal relations; states relations; educational relations; research extension; and research information. Each of these divisions comprises larger or smaller series of committees, each with its special problem or subject. There are other committees, administrative and technical, which affiliate directly with the executive board of the Council. Its general administrative officers are a chairman, three vice-chairmen, permanent secretary, treasurer, and a chairman of each of the various divisions. All of these, except the permanent secretary and treasurer, are elected annually by the executive board or by the members of the division."

"The Council is neither a large operating scientific laboratory nor a repository of large funds to be given away to scattered scientific workers or institutions. It is rather an organization which, while clearly recognizing the unique value of individual work, hopes especially to bring together scattered work and workers, and to assist in coordinating scientific attack in America on large problems in any and all lines of scientific activity; on those problems which depend on the cooperation of many workers and laboratories, either within the realms of a single science or representing different realms in which various parts of a single problem may lie. It particularly intends to avoid duplication or to interfere in the slightest degree with work already under way. To such work it only hopes to offer encouragement and support where needed and possible to be given. It hopes to help maintain the morale of devoted isolated investigators and to stimulate renewed effort among groups willing but halted by obstacles. It will try to encourage the interest of universities and colleges in research work and the training of research workers, so that the inspiration and fitting of American youth for scientific work may never fall so low as to threaten to interrupt the constantly needed output of well-trained and devoted scientific talent in the land.

"The methods of contributing practical assistance to American science in harmony with the general point of view and policy outlined above which the Council has so far adopted are various. One is the establishment of special committees of carefully chosen experts for specific scientific subjects or problems urgently needing consideration, which plan modes of attack and undertake to find men and means (with the assistance of the general administrative offices of the Council) for carrying out the plan. About eighty such committees are now in existence. Another is the bringing together of industrial concerns interested in the development of the

scientific basis of their processes and inducing them to support the establishment of special laboratories or institutions devoted to this development under the advice of experts representing the Council. Another is the stimulation of larger industrial organizations, which may be in the situation to maintain their own independent laboratories, to see the advantage of contributing to the support of pure science in the universities and research institutes for the sake of increasing scientific knowledge and scientific personnel on which future progress in applied science absolutely depends. Other methods are the direct maintenance of university research fellowships; the publication of valuable scientific papers for which there is at present no other suitable prompt means of issuance; the preparation of bibliographies and abstracts of current scientific literature; the setting up of well-considered mechanisms for the collection and distribution of information on current research, university and industrial research laboratories and facilities, research personnel, etc.; and the dissemination through the press and magazines of popular but authentic scientific news and information for the sake of increasing the public interest in and support of productive scientific work. Still other forms of activities might be listed, but those given adequately illustrate the Council's methods."

I have quoted from the report of the Chairman of the Research Council, so that you can get just a bird's-eye view of the way he visions the functioning of the Research Council at the present time. If you are interested in the problem you ought to get the Fifth Annual Report of the National Research Council,* a volume of a hundred pages. I can only give you the barest outline, but I perhaps can give you enough so that you will see how big the problem is, how many interests are involved, how many have to be involved, and what enormous possibilities there are.

Appropriations have been received from the Rockefeller Foundation for the support of the National Research fellowships in physics and chemistry. In April, 1919, the Foundation appropriated a total sum not to exceed $500,000 for the support of these fellowships in the period May 1, 1919, to June 30, 1925; also for the support of the necessary expenses in 1920 of the special committees of the division of physical sciences. The Rockefeller Foundation also appropriated in December, 1920, the sum of 15,000 to defray the expenses of the committees of the division of physical sciences in 1921. The Commonwealth Fund made an appropriation of $2,000 a month for the six months of January to June, 1920, to help meet the current expenses of the Council.

I come now to its engineering relations; the Engineering Foundation ,established in 1914 by the United Engineering Society, representing the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, co-operates closely with the division of engineering of the National Research Council. While the Engineering Foundation reserves the right to conduct researches under its own direction, it is now supporting some of the research projects of the division of engineering, notably a research in the fatigue phenomena of metals, and in addition is paying part of the administrative expenses of the division. For the support of an investigation, under the direction of a special committee of the division of engineering, on fatigue phenomena of metals, the Engineering Foundation appropriated $15,000 for 1920 (with $15,000 more pledged for 1921) and the General Electric Company gave $30,000 to extend the research. The University of Illinois provided expert service and use of laboratories and equipment equivalent to $6,000.

*1701 Massachusetts Ave., Washington, D. C.

An industrial organization has pledged itself to give the Council $25,000 annually for five years for use in the promotion of fundamenetal research.

The Southern Pine Association appropriated $10,000 for the use of the committee on forestry of the division of biology in organizing and maintaining certain forestry researches.

E. I. Du Pont de Nemours & Company gave $5,000 and the General Motors Corporation $25,000 to the Council for the special use of the research information service.

The education of the public to the appreciation of research and its values is one of the big items that is under consideration. You will be interested if I outline just a few of these larger activities. One is the personnel matter. Because the research spirit has gotten into your industries, they are at the present time, pulling upon the universities. Your industries are establishing their own research laboratories, being stimulated to do it in part by the engineering division and the engineering foundation.

The way in which industrial research ought to be carried on, and can be best carried on in the United States is, in the opinion of some, to get the industries interested in a larger way by presenting before them the type of work that the General Electric Company, or the Telephone Company, do in their research organization; to get the industries to see the commercial values of research and provide their own research laboratories. The oldest industrial research organization in the country is the Du Pont's, which is very old and very well equipped. Within the last year or two, the Standard Oil Companies have established research laboratories. All of them had chemical research. But they have been establishing physical laboratories. The Harvester Companies are doing it. It is being done all over the country in a very unusual way at the present time. The industries are beginning to see the value of it.

Under this demand the universities are having their best personnel called away. It is of the utmost importance, for the future, that the very best instruction, the very best kind of research facilities be maintained in the universities; facilities for training men in research.

How then is the pure research which underlies the industrial, upon which it absolutely depends, to be carried on? One answer is, the industries must support the pure research in the universities. Everybody agrees that the place for pure research, or the place where it has to be, is either in detached research institutes, of which we have a few in the country, or else in universities. The commercial laboratory will do a certain amount of it. The General Electric Company, the Telephone Companies are doing some, but the fundamental motive behind the companies is, and it ought to be, the commercial motive, not the motive of pure research.

I have my doubts as to whether it is feasible for research in the universities to be financed in the way indicated, because I doubt whether Industrial Boards of Directors have the power or the inclination to spend their funds thus. It is true that that is coming, to some extent. I should mention, for example, that the General Electric Company has voted thirty thousand dollars for the support of a research in connection with its work in connection with one or two particular projects and that the American Bell Telephone Company voted twenty-five thousand dollars a year for pure research in connection with National Research Council

enterprises. I doubt though whether this method is going to grow to a very large extent.

I think your universities will have to depend, not upon the industries, but upon the interest of men who acquire their wealth from the industries and who are public-spirited; who find that they can make their contribution to the future most effectively in putting their wealth back into pure research channels.

To show you how far the organization has gone in the endeavor to develop personnel, the Research Council officers went before the Rockefller Foundation, and secured an appropriation of five hundred thousand dollars to be used in five years for research fellowships in physics and chemistry in connection with American universities. This is an interesting fact—the men who were behind that enterprise wanted physics and chemistry to be emphasized. One of the most influential of them, a medical man himself, has said, "I would rather have in my laboratory a man who knows physics and chemistry than a man trained to medicine." Physics and chemistry are the foundations of Public Health from his point of view. He and his associates convinced the Rockefeller people that they would make a wise expenditure of their funds by providing for advanced training of men in physics and chemistry. These National Research Fellows can go anywhere they wish in the graduate departments of the American Universities. This for the sake of recruiting in the Universities a scientific personnel, which is now being decimated by the pull of the industries. I think this is working successfully.

Public dissemination of information is another big enterprise. This was financed by Mr. E. A. Scripps, of Miramer, California. He set aside the interest on a half a million dollars for the sake of starting a program for the dissemination through the daily papers, magazines, lectures, motion pictures, conferences, of correct, authentic, newsy items of popular science. This has been organized under the joint auspices of the National Research Council, the National Academy of Sciences, the American Association for the Advancement of Science, the Scripps estate, and a group of professional journalists. The service is managed by a board of trustees of fifteen members, three selected by each of the five groups above mentioned. Doctor W. E. Ritter, of the Scripps Institution at La Jolla, is president and treasurer, and Doctor Vernon Kellogg, of the National Research Council, is vice-president and chairman of the executive committee. The control of those funds, is in the hands of the representatives of these scientific bodies. The "Science Service" working from the offices of the National Research Council in Washington, starting the dissemination of correct and accurate scientific information to the daily press, with a view of educating the public, not only to the values of sciences, but in endeavoring to get the public to think accurately; and to get things as they are, instead of incorrectly. Anything you see under the head of "Science Service" is prepared by that organization. It is a great, big enterprise, bound to have large values. It is expected in the end to be self-supporting.

Those are some of the large enterprises. Let me mention just a few of the smaller ones.

The division of Federal Relations has given consideration to the problem to make suggestions as to what research should be undertaken by the Government, what should be left to the universities, and what to the industries. To contribute towards a solution of the problem, a committee on scope of Government services was appointed to make a broad survey of scientific bureaus of the Government and recommend a research policy.

The Federal Relations Division is a Division getting together the bureau chiefs at Washington and the heads of industrial organizations, for the sake of forming some judgment as to where the lines ought to be drawn between governmental research such as carried on in the bureaus; and that type of research which may best be done in the universities, and again that type which can best be done in the industries. Of course, this is a difficult problem, but the discussion is of large importance.

During the year the Division of Foreign Relations has assisted in the formation of American sections of the International Mathematical Union and of the International Union of Scientific Radio Telegraphy.

The Division of States' Relations has undertaken a study of facilities for research at the command of scientific departments in the State Governments, such as boards of health, boards of agriculture, fish and game commissions, conservation commissions, office of the State Forester, State Geologist, State Highway Engineer, etc. A study of the nature and extent of the co-operation in scientific work between Federal bureaus and corresponding State scientific departments or other non-federal agencies, has been undertaken jointly with the Division of Federal Relations.

Members of the Division of Biology and Agriculture brought to the attention of the chairman of the Division of Research Extension the opportunity for co-operation between scientific groups and industrial groups interested in the control of injurious insects and plant diseases. The Tanners' National Council, which has supported a research laboratory for some time, has become interested in the possibility of founding a school of tanning which would plan to accomplish in the United States objects similar to those of the tanning schools abroad. Through the activities of the Division of Research Extension, the Council has requested the National Research Council to assist them with their problem of deciding upon the type of school, its field of activity, its location, etc.

There are large annual losses in the tobacco industry from diseases which are not well understood, and the desirability of supporting research plans to produce better disease-resisting strains was brought to the attention of the Division. Steps have been taken to interest large tobacco concerns for the project, but those who have been made acquainted with it are much interested in the possibilities, and the work of organizing the project is still under way.

The Southern Pine Association have provided $10,000, covering a period of three years, for the support of the work of the committee on forestry, division of biology and agriculture. Subsequently field work was organized under the regional director in the South and the research is under way.

Work has continued with reference to interesting the textile industry in the application of science to its production problems. Contact has been made with the National Wool Manufacturers' Association through its secretary, for whom information has been secured, and an effort is being made to assist him in having the industries engage upon certain problems which they have selected as important for their progress.

The Research Information Service has been organized primarily as a general clearing house for information concerning or affecting scientific and technological research. The chief purpose of the service is to advance science and productive scholarship by information concerning results of research, problems, projects, methods,, procedures, laboratory construction and equipment, apparatus, publications, funds, sources of information or advice, personnel, etc. Every effort is being made

to avoid duplicating the work of other informational agencies and to coordinate and utilize their activities and materials in connection with the demands made upon this service. It was originally believed, and it now appears that this belief is justified by the facts, that an expert informational service can be made to encourage profitable co-operation in research, to lessen undesirable duplication of work, to increase the support of fundamental scientific investigation, to promote exchange of information concerning progress in closely related investigations, and to render possible increasingly satisfactory distribution of research effort and greater wisdom in selection of problems for investigation.

To take one more single case, the work of the Committee on the Heat Treatment of Carbon Steel, is an excellent illustration of what co-operative research is. The aim of the committee is to increase our now fragmentary knowledge of the influence of heat treatment on the mechanical properties of carbon steel, and especially to learn the conditions which most economically and advantageously set up the sorbitic state, the most valuable for engineering purposes. The method is to subject specimens of steel of the carbon content most used for engineering work, 1.34 per cent, 1.52 per cent, and 0.75 per cent, and most suited to sorbitizing, to various heat treatments, and to test the mechanical properties thus induced. The steels are the same as are used by the committee on fatigue phenomena. The tests are expected to show the merits of sorbitizing treatment over crude annealing. The program of the work of this is as follows: Steel specimens are provided by the John A. Roebling's Sons Company, and rolled into round bars by the Carpenter Steel Company. The heat treatments and some microscopic examinations are being conducted in the private laboratory of Doctor H. M. Howe. Microscopic examinations are also made at the University of Minnesota. Magnetic tests are made at the Bureau of Standards. The test pieces are being machined by the Bureau of Mines at Pittsburgh, the Bethlehem Company, the Neverslip Company, the General Motors Corporation, and the American Tool and Machine Company, without charge. The mechanical tests are being made at the Bureau of Standards and at the Watertown Arsenal. Mr. Henry M. Howe is chairman of the committee. That is a pretty good illustration of co-operative research between industries in attacking a particular problem pertinent to these industries.

In order to awaken your interest and give you a glimpse of the magnitude of this enterprise, and the sort of things that are being done, I have touched upon the things that particularly affect us, as a group here. However, the medical research groups, biological research groups, agricultural research groups, have equally large problems. The point of it is that the National Research Council ties them all together into one organization. Almost all of these things do actually dovetail into one another. It is very desirable to get the interchange between the two, particularly with reference to the solution of the individual problems, and also with reference to having the borderland fields occupied.

But now, what is it all for, anyway? That is the question that I am raising here—the question of the values of it all. It is quite true that the average man who does not look fifty years ahead, who does not look even one or two years ahead, is inclined to wonder whether you are not going to waste a lot of funds. Undoubtedly you will waste some funds. Some fraction of all research work will be wasted.

However, let me show you what this sort of activity has accomplished. Let me draw you a picture; let us go up into an Einstein airplane, so that we can get away from the immediateness of our present surroundings; where we can violate all

the relations of time and space, and look down on a few points in geography and in time; let me give you a picture which Breasted, my colleague at the University, brought back when he came from his mission to the Near East last spring. He showed me some photographs of men on the banks of the Tigris and Euphrates rivers, who were plowing the ground with crooked sticks and putting the hard-earned product of their toil upon crude rafts that were made from the skins of sheep and laboriously paddling them across the river for sale on the other side. Then he threw on the screen a picture which he had taken from one of the Babylonian tablets, four thousand years ago, which showed the same scene, exactly, the same kind of rafts, the same sheep skins, and goat skins supporting the rafts. Four thousand years without one bit of progress, men doing nothing from generation to generation except reproducing their kind and living a miserable existence, and passing on. Again, I heard last winter, Mr. Sam Higginbotham, a Princeton man, who is engaged in agricultural experiments in India, and who went there to try to give them a little knowledge of agriculture. He pictured millions of men in India at the present time, going into the field in the morning, with a handful of raw grain. That is all they had to eat from morning to night, and they were thinking they would be perfectly happy if they could get all they wanted to get of that. Or consider China, with millions of people starving this winter if they do not get help from the Western world. It is a discouraging picture of the world, when you see the struggle for existence so intense that a good fraction of the world is starving to death.

Now, if you want to be a little bit encouraged, come over and take a picture or two in this country. I will paint only two. To get one somewhat parallel to that taken on the banks of the Tigris and Euphrates, go to New Orleans and circle over the Southern Pacific Railroad, and watch the train bearing two hundred tons of produce from Texas, all of which has been produced by steam or tractor plows and steam threshers, pulled, without uncoupling the engine, on a huge ferry and in fifteen minutes it is on the other side, ready to be distributed to millions of people on the east side of the Mississippi river.

Or take another picture. I could take one from Chicago, but I will take one a little further away. Go to the biggest copper mine in the world, at Magna, Utah, right out from Salt Lake City, and you will see there a mountain of two per cent copper being shoveled away with relatively little human help by means of big steam shovels. You will see a car of ore weighing a hundred thousand pounds pulled a few miles to the mill; you will see that whole thing lifted some fifty feet, and all turned out over and the ore dumped into the mill with scarcely a man in sight. When you get near the mill you see a great senseless iron Cyclops grinding that ore to powder. Then you watch it being separated by the unseen forces of adhesion and cohesion in the flotation process, with almost nobody in the mill. Seventy thousand tons of ore run through those mills per day; an equal amount of water runs through them, the sulphides taken out, and copper produced at less than ever before in the world's history. Fifteen years ago two per cent ores could not be worked at all.

We hear a great deal about redistribution of wealth and social reconstruction. And yet look at what is actually the case in this country where pictures like the foregoing can be seen. Any unskilled laborer, in this country, receives more than twenty-five times as much, not in face value of money, but in the purchasing power of his money, as do those laborers in India or in China. In other words, in this country each unskilled laborer has twenty-five Indian slaves who are doing his work for him. Why? Because in a certain fraction of the world a hundred or two hun-

dred years ago men like Galileo and his successors, Newton and Faraday, saw the values of beginning to study out how Nature worked, of getting hold of Nature's forces and controlling them for the sake of doing man's work for him. It is only in the regions of the earth where such an idea got started, namely in Western Europe and in this country, whose ideas came from Western Europe, that such lights as the foregoing are possible.

A group of men like you do not need to be educated up to the values of looking farther than at the immediate needs of an industry. You all know that that is immensely important just as well as I do. Yet it is worth while for us to look at pictures like the above to see what has been done, and then to reflect that within the last ten years we have learned of the existence of sub-atomic stores of energy which some day we may hope to tap. Research work is, in a way, a gamble. The first thing is to find that these energies are there. The next thing is to find out whether it is possible to disintegrate atoms by external agencies. We can already answer both of these questions in the affirmative. Can we go farther? Perhaps, but only through research. Research must be supported in the most complete way in this country, which has the wealth, if we are to lead rather than follow in the progress of the world.

If one is inclined to be discouraged at a time like this when there is a great business depression, one can console himself by a little rhyme which I saw in the Outlook some eight or ten years ago, after an election:

"My grand-dad notes the world's worn cogs and says
"We're goin' to the dogs;
"His grand-dad, in his house of logs
"Thought we were going to the dogs;
"His dad, amid the Flemish bogs
"Knew we were going to the dogs;
"The cave man, in his queer togs
"Swore we were going to the dogs;
"But this is what I would like to state—
"Those dogs have had an awful wait."

TESTS OF BUILDING COLUMNS UNDER FIRE CONDITIONS

Abstract of Paper presented February 14, 1921.

By W. C. Robinson,* M. W. S. E., and S. H. Ingberg,** M. W. S. E.

An experimental investigation of the resistance of columns, loaded and exposed to fire or to fire and water, with record of characteristic effects, conducted in co-operation with the Associated Factory Mutual Fire Insurance Companies and the National Board of Fire Underwriters, the tests being made at Underwriters' Laboratories.

METHOD AND SCOPE.

The fire exposure was produced by placing the column in the chamber of a gas-fired furnace, whose temperature rise was regulated to conform with a predetermined time-temperature relation. Measurements were taken of the temperature of the furnace and test column and of the deformation of the latter due to the load and heat.

The test columns were designed for a working load of approximately 100,000 pounds, as calculated according to accepted formulas, the amount varying somewhat for the different sections. The working lead was maintained constantly on the column during the test, the efficiency of the column or its covering being determined by the length of time it withstood the combined load and fire exposure.

In the fire and water tests, the column was loaded and exposed to fire for a predetermined period, at the end of which the furnace doors were opened and a hose stream applied to the heated column, the severity of the test being regulated to correspond with the degree of resistance developed by the corresponding type of column in the regular fire tests.

The paper reports on 106 tests of columns, of which 91 were fire tests and 15 fire and water tests.

The series includes: (1) tests of representative types of unprotected structural steel, cast iron, concrete-filled pipe, and timber columns; (2) tests wherein the metal was partly protected by filling the reentrant portions or interior of columns with concrete; (3) tests wherein the load carrying elements of the columns were protected by a 2-inch or 4-inch thickness of concrete, hollow clay tile, clay brick, gypsum block, and also, single or double layer of plaster on metal lath; (4) reinforced concrete columns with 2-inch integral concrete protection.

The covering materials for each class of protection were obtained from the main producing regions of the country, the object being to include samples from the principal mineralogical subdivisions that find general application in building construction. A large number of auxiliary tests of constituent materials were made, which are described and results given in a separate section with the aid of diagrams and 30 pages of tabulations, forming a fairly comprehensive source of information

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on the physical and chemical properties of the materials used in modern fire resistive construction.

In placing the columns and coverings, the work was planned so as to reproduce as nearly as possible the conditions obtaining in building construction, in point of methods of application and workmanship. This was done to make the results of the tests applicable without undue allowance for differences that otherwise might be doomed to exist between the test column and a similarly constructed member in a building.

TEST RESULTS.

These are presented in 12 tables and 128 figures and diagrams, the latter comprising views of columns before and after test, the time-temperature curves for the furnace and 6 to 12 points on the test column, and unit deformation with corresponding average column temperature curves. Test logs give detailed developments during each test.

The results in point of time to failure in the fire test are studied with reference to size of column, and for given column and covering materials, relations established between fire resistance and area of solid material in the column cross section. The test results, supplemented by investigations on the properties of the column materials under heat and load also afforded means for determining approximately the useful limit of a column when loaded and exposed to fire. A summary of general characteristics of the column and covering materials, as developed in the fire tests and the auxiliary tests, is made, which can in part be applied to building members other than columns. A summary is given of methods used and results attained in previous investigations and an effort made to interpret the latter with the aid of the information now available.

FIRE RESISTANCE PERIODS.

The results of the tests are finally summarized in terms of hours and minutes of fire resistance afforded by the different types of columns and protections tested. The resistance period is taken as a portion (two-thirds) of the average time to failure in the fire test, the deduction being made to allow for incidental variations in material and workmanship of columns and coverings as tested and as installed in buildings and also for differences in load and fire condition that cause variations in results with nominally comparable columns. Requirements relative to resistance to water application, are limited to ability to sustain load without danger of immediate collapse in case of fire recurring after fire and water exposure. Application of the results is extended beyond the particular materials tested as far as existing knowledge of the properties of related materials justifies it, this being done to give the results greater continuity. Interpolation is also made for a covering thickness intermediate between those tested.

The resistance periods thus derived vary from 10 minutes for unprotected structural steel columns to 8 hours for similar columns covered with 4-inch thickness of concrete made with fire resistive aggregates and reinforced concrete columns made with the same aggregates. Filling the reentrant portions or interior of structural steel columns with concrete gave them resistance periods ranging from ½ hour to 3½ hours, depending on the size and shape of the column and the concrete aggregates employed. Single layer protection of plaster on metal lath applied to struc-

tural steel columns gave ¾ hour resistance and double layer with airspace between layers, 1½ hours. Two-inch concrete protection on structural steel columns gave resistance periods from one hour to four hours, depending on the aggregate employed. The concrete made with sand and pebbles high in silica (chert and quartz) developed disruptive effects on exposure to fire, which is ascribed (1) to points of abrupt volume change existing for chert as low as 210°C. and for quartz at 573°C. where it is transformed into the mineral tridymite; (2) to disruption of the pebbles from evaporation of the chemically combined water of the chert, and water occluded in tiny cavities in the quartz when it crystallized from the molten condition. Concrete made with trap rock, granito, sandstone, or hard coal cinder aggregate proved superior to that made with siliceous gravel. The highest resistance obtained with concrete made with dolomitic limestone and calcareous sand. The 4-inch concrete protections developed resistance periods from 2½ to 8 hours, the variations with the aggregate being similar to that for the 2-inch protections.

Hollow clay tile on structural steel columns gave periods from one hour to three hours, depending on the type of clay and method of application. Tile made from semi-fire clay burnt to medium hardness developed greater freedom from cracking and spalling than any tile tested. Hard burnt semi-fire clay tile evidenced greater effects from fire exposure and with surface clay and shale tile these disruptive effects were very marked. Little or no difference in resistance was noted as between the 2-inch and 4-inch thickness of hollow tile, the time to failure being dependent on the area of solid material rather than on the thickness of the airspace. Filling the interior with concrete or tile appreciably increased the resistance and stability of the covering and interior metal ties were found to be superior to outside wire ties in holding the tile in place. Solid clay brick set on end and edge to form a solid covering about 2½ inches thick outside of the steel, proved somewhat unstable on exposure to fire and developed a resistance period of only one hour, while laid flat in the usual manner to form a 4-inch covering thickness, 5-hour fire resistance was developed. Solid gypsum block, 2 inches in thickness, laid outside of flanges and edges of structural steel columns and with space between blocks and flanges filled with gypsum mortar, gypsum blocks, or poured gypsum filling, gave 1½-hour resistance and similar covering made with 4-inch solid blocks gave 3½-hour resistance, the failure being due in all cases to shrinking, checking and disintegration of the blocks, which caused them to fall off and expose the steel.

Round hollow cast iron columns developed 20-minute fire resistance as tested unprotected and ½-hour resistance when unprotected and filled with concrete. Protections approximately 2 inches in thickness and consisting of Portland cement plaster on metal lath, hard coal cinder concrete or round porous semi-fire clay tile increased their resistance period to 2 hours. Steel or wrought pipe not smaller than the 7-inch standard size, filled with concrete and reinforced in the fill with structural angles, gave ¾-hour resistance.

Reinforced concrete columns with 2-inch integral concrete protection, gave 5-hour resistance as made with trap rock aggregate, and 8-hour resistance as made with limestone aggregate.

Pine and fir timber columns with unprotected cast iron or steel caps gave 25-minute resistance, with column and cap covered with ⅜-inch gypsum wall board gave ¾-hour resistance, and with protection of Portland cement plaster on metal lath gave 1½-hour resistance. The cause of failure of the timber columns was loss of strength of the wood at the cap bearings, due to conduction of heat from

the flanges of the metal caps to the bearing plates and into the wood, which caused it to soften, crush, and induce slipping or fracture of the caps. While the fire test reduced the area of the columns by 29 to 55 per cent, their resistance to fire and load outside of the bearings was not fully developed in the tests.

The series fairly covers the range of current practice in structural steel columns and perhaps also, in proportion to the extent of their use, in that of the other column materials except reinforced concrete, which latter is the subject of a special investigation recently completed by this Bureau. The studies made on effect of size indicate that the results obtained with the columns tested, which were representative of the smaller sizes in general use, can be extended with safety to larger columns.

"THE ENGINEERING OF BUILDINGS FOR TELEPHONE SERVICE"

By Thos. B. Lambert*

Presented May 5, 1921.

Above that marvelously beautiful entrance to the Transportation Building of the Columbian Exposition of 1893, there were two classical quotations; one by Lord Bacon:

> "There be three things that make a nation great and powerful: a fertile soil; busy workshops and easy transportation for men and goods from place to place."

The other by Thomas Macaulay:

> "Of all human inventions, the alphabet and printing press alone excepted, those inventions which have served to abridge distance have done the most for human civilization."

To these inscriptions so aptly placed and chosen, we shall hereafter refer.

The larger American cities have no parallel in history in magnitude or congestion. Even the exaggerations that have crept into the legends of the past fall short of picturing conditions that now exist in our large centers of population.

The very causes that make for and produce the great cities of today, go still further and develop those super-congested business structures which for lack of better words, we have learned to call "skyscrapers." In Chicago, for instance, one single twenty-story building stands on half an acre of ground, in the financial commercial district and houses for employment at least 6,000 people. On the basis of census statistics, this number of employes represents the business district and activities of a city of 30,000 inhabitants.

Such buildings are veritable "cities on edge," cities with no vacant lots, every house built and ready for occupancy served with elevators that function as street cars, and halls that serve as public highways. They have complete water, sewer, heating and lighting systems and supply janitor service to the tenants all included in the annual renting charges.

With all of these community conveniences and necessities, it is interesting, even fascinating, to note how little value they would have were it not for the telephone service,—the one thing that makes such congestion possible or endurable.

If the elevators should fail to operate, people could walk up and down the stairways, but if the telephone service should be taken away, business in such a building would practically cease until the service was restored.

If a building of this type were wholly self-contained, requiring no contact with the outside world, the management could and probably would install and maintain its own private inter-communicating telephone system with its attendant advantages. But the world is bigger than that; it has little use for the "Soviet Telephone."

The universality of such a country-wide system as that developed by the Bell Telephone Company gives to the telephone its chief and immeasurable value.

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In modern civilization, there is no room for a hermit—no place for a man or a business without a telephone.

In the development of the telephone industry, there have been many and intricate problems, and among them the one of providing adequate facilities for telephone service in the modern office building has been kaleidoscopic in its changing phases.

It not only involves cabling the building itself, but when Aladdin's Genii suddenly erect a great office building in a district already crowded with telephone service, new conditions are created. Very often a new line of conduit must be laid in the streets, additional office switchboard equipment and distribution facilities provided, together with a great volume of interdependent details unknown to the public and too often little known and appreciated by those in the business not directly engaged in such studies.

For the Telephone Company under normal conditions, to be prepared for a general increase in service, is a comparatively easy matter, but forecasting just where and when the next "skyscraping" office building will be erected is one affair, and forecasting correctly, far enough ahead to be able to provide underground facilities and central office equipment that shall be adequate, not wasteful, is quite another matter.

Estimating future service demands is properly the function of the Commercial Department; and the whim of an owner or the collapse of one of his financial ventures may at any time make a previous study of telephone requirements incorrect, however carefully prepared.

When a building has been planned and contracts let for its construction, the definite problem of cabling the building for telephone service is begun. Through the architects and owners, the telephone engineers undertak to obtain enough reliable information relative to the proposed building to warrant them in formulating a definite plan of supplying the building with the necessary telephone service. As before stated, this frequently includes, and must consider the question of additional underground cables and central office equipment together with the more specific problem of planning and installing cables and terminals in the building itself that shall meet the immediate demands, and anticipate the future requirements with the least amount of idle plant.

Through long established custom, no one questions the equity and justice of a building owner paying for the installation of pipes that distribute gas and water throughout the building; and with the advent of electric light and power service, and the concomitant fire risk attendant upon poor installation, the owners willingly undertook to furnish the conduit, wires and equipment necessary for such service in the building. But when the telephone entered the business field, there was an apparent reversal of form.

The Telephone Companies generally undertook to furnish the entire telephone equipment including the wires and instruments placed in the patron's property. This, however, never contemplated the placing of any conduit, moulding or the like which became a part of the permanent building plant. In this connection, the Telephone Companies have always reserved the right to remove whatever equipment they furnish, in cases of changes or discontinuation of service.

This practice was the logical sequence of good telephone service which in some respects differed from that of other public utilities.

The water, gas and electric light service is strictly an individual one insofar as any building is concerned. There is "no inter-relation" between buildings; not even between floors of the same building.

The failure of the water pipes in one building has no effect whatever on the service in another except the negligible tendency to improve it by a slight increase in pressure.

The same is true of gas and electric light, but with telephone service the uninterrupted intercommunication feature applied to a country-wide territory is its greatest single factor of value. Every telephone is on speaking terms with every other telephone.

With this fundamental in mind, together with a knowledge of the wretched service given in some of the European countries where subscribers keep their own instruments in repair, the Bell System undertook to control the entire plant, even at a sacrifice of earnings, in order to give better service.

This practice originated at a time before the telephone had come to its own in the field of importance.

In the evolution of the art, one telephone alone had no value—two became of scientific interest and held the potential power of one of the most important industries that go to make and maintain a higher order of civilization. Thus, the telephone growing in value to the public, in a geometrical ratio as their number increased has become so important and far reaching that the owner of a building should be, and naturally is, equally interested with the Telephone Company in providing means for supplying telephone service to his tenants. Without telephone service, his building is not rentable.

This fact being understood by the owner of a prospective building, little difficulty is experienced in persuading him to provide suitable cable and wire paths, such as conduit, runways and mouldings in which the Telephone Company may place the necessary equipment for serving the building as it is evidently to his own advantage. Usually the Field Engineer for the Telephone Company at the request of the Architect goes over the plans with him and indicates a suitable conduit system that will care for the estimated service, allowing a safe margin for growth and changes.

The density of service expressable in the number of square feet of rentable floor area per pair of available conductors is an important fundamental, and being once determined from the information obtainable, becomes a basis for the detailed plans of cabling the building.

Apart from the underground service that will be required, a building cable plan includes a main terminal or distributing frame usually located in the basement and from which one or more riser feeders lead by way of wire shafts to the several floors where, by means of branch cables, further distribution is effected to the several floor boxes or terminals. The floor cables are usually distributed by means of conduit and wire moulding of sizes and types approved by the Telephone Company. The floor terminals are placed with the idea of minimizing the wire runs necessary for the installation of subscribers' instruments, and the distribution of conductor pairs to these several terminals is intended to provide both a flexible and an economic installation.

The present practice of cabling office buildings for telephone service leans decidedly toward having a certain proportion of conductor pairs running directly from

the various floor terminals to the main frame in the central office and not appearing at the basement terminal. This system would be ideal if the estimated requirements for these "direct feeders" could be made reasonably correct. In the present state of the art, it is reasonably certain that there will be at least one direct feeder necessary for each office, and for every one of such feeders that is used, there is a distinct economy of cost of installation, which also minimizes annoyance to both landlord and tenant. If, however, there should be many unused direct feeders and the building involved a long distance from the Central Office, then the question of idle plant becomes a factor for consideration. This phase of the cabling problem is an example of the many that must be considered in planning cable distribution in the larger office building.

It has been suggested that the upper limit of telephone density in any office building would be one pair of conductors, or one instrument per "desk"; approximately one pair per hundred square feet.

Such a density seems hardly possible at the present state of the art, though we have in Chicago one building in the Board of Trade district that has one telephone to each 141 square feet.

This condition is abnormal and cannot be accepted as standard for other buildings even though indicating a possibility in future development.

The Telephone Engineer is concerned in providing adequate facilities for service with a minimum expense of installation and maintenance and so far as possible provide a system that shall anticipate future changes of tenancy and growth of service. In general, it is his business to blend technical experience with prophecy and make a success of it.

And now, let us for a moment turn back to the inscriptions over the entrance to the World's Fair Transportation Building of 1893. One that says:

> "There be three things that make a nation great and powerful: A fertile soil; busy workshops and easy transportation for men and goods from place to place."

The other saying:

> "Of all human inventions, the alphabet and printing press alone excepted, those inventions which have served to abridge distance have done the most for human civilization."

Had Lord Francis Bacon or Thomas Macauley been able to foresee the telephone and its possibilities, what encomiums they might have written, for no other invention has approached the telephone in abridgement of distance—it has annihilated it.

About the time the celebrated Brooklyn Suspension Bridge was designed and built, Bell invented the telephone.

The erection of the bridge was spectacular. At its completion, bands played and banners waved. Easy transportation for men and goods had been accomplished between two great cities.

Bell's invention, the telephone, was modestly, earnestly struggling for recognition. No great men made speeches, no bands played or banners fluttered, but had Bell invented the telephone twenty years earlier, the Brooklyn Bridge would have been long delayed. The bridge makes transportation easy; the telephone makes it unnecessary.

THE ALASKA RAILROAD

By Frederick Mears*, Colonel, Corps of Engineers, U. S. A.

Presented January 20, 1921.

I have been asked to speak before the Western Society of Engineers this evening on the subject of the Alaska Railroad—the railroad that the United States Government decided to build, for the purpose of assisting in the development of Alaska, our most northern territory.

I was glad to accept this invitation and appreciate the opportunity of presenting some of the facts about Alaska, to such a representative body of men, with the hope that some of the mystery in which Alaska continues to be enveloped will be somewhat removed—leading to a better understanding of that valuable country.

While the size and geographical position of Alaska is probably a matter of common knowledge, it may not be amiss to commence with a brief physical description of the territory—with particular reference to the transportation routes by land and sea.

Though Alaska is often loosely referred to as an Arctic province, nearly three-quarters of its area is within the north temperate zone. The climate of the coastal section is comparable with that of Scotland, but somewhat warmer. That of the inland regions is not unlike the climate of northern Minnesota, Alberta and Manitoba in Canada. The northern section, bordering the Polar Sea, is the only one in which Arctic conditions prevail. In Fairbanks—(Lat. 65°, about parallel with northern Norway)—in the summer time, the same clothing is worn as in Chicago.

Leaving out of consideration the fisheries of Alaska which produced $52,000,000 in 1919, the resources of Alaska are principally mineral, timber, furs, and agricultural products—the latter for home consumption.

The total mineral production to the end of 1919 was $437,000,000. The output for the year 1919 in gold alone was $9,000,000—in other minerals—principally copper, silver, coal and petroleum, $10,000,000. Furs produced over $4,000,000 in 1919 and lumber about $1,000,000.

I am not one of those who desires to paint an extravagant picture of the future of Alaska—for I believe, by so doing, more harm than good would result. That Alaska is worth developing—in my judgment—is beyond the shadow of a doubt.

Suppose for instance that a private corporation actually owned all of Alaska—would it leave its undisputed resources lie dormant?—or, would it spend some money to develop the country and recover its assets? They would undoubtedly follow the latter course as being wise and profitable. To my mind, it is not to be wondered at that Alaska has not advanced more rapidly, when the example of our Western Plains is considered in the light of a parallel. It has taken 25 to 30 years to develop our West—which has been in immediate touch with other parts of continental United States. Furthermore, most of the western trans-continental railroads were endowed with immense land grants which the railroad companies proceeded to make use of in a most liberal manner in the encouragement of settlement and the building up of traffic. It is much more difficult to bring about similar results in a land situated six or seven days sailing time beyond the shores of the United States. Nothing but the gradual dissemination of truth regarding Alaska will change this situation. Government conservation restrictions—once a serious detriment to Alaskan development—have now been largely withdrawn, one of the

*Chairman and Chief Engineer, Alaska Engineering Commission.

latest steps being the return of the oil lands to private entry, which was brought about by the passage of an Act of Congress in 1920—and it is sincerely to be hoped, that the Government will continue its liberal policy with Alaska and grant further aid and encouragement in the development of that great territory.

Alaska has an area of approximately 590,000 square miles, about twelve times the size of the State of New York, or practically one-fifth the size of the continental United States. Its distance from the United States is best described by referring to the trade routes leading from our northwest Puget Sound country.

Seattle, the well recognized gateway to Alaska, is the headquarters of two or three American steamship lines in Alaskan trade, as is Vancouver and Victoria, British Columbia, for the Canadian steamship lines.

The usually travelled route is via the inside passage through the Canadian and Alaskan Archipelago—700 miles from the northwest corner of the State of Washington to the south point of Alaska—thence 520 miles along the Alaska Panhandle to the southeast corner of the main part of teh territory. It should be noted that the main part of Alaska lies west of the 141st Meridian—forming the international boundary line between Canada and Alaska.

The south coast of the main Alaska peninsula is about 900 miles long—measured between parallels of longitude—with a coast line of many times that length. Contrary to some popular beliefs, the south coast, lying at approximately 60° North Latitude, is entirely ice-free during the year, permitting uninterrupted ocean traffic to all of the principal south coast ports. There are comfortable ocean steamers plying on regular schedules in this Alaskan service—in summer reaching Anchorage at the head of Cook's Inlet, and in the winter, ending their voyage at Seward, the southern terminus of the Government railroad.

Nome, in the far west central section of Alaska, near Latitude 65°, is served by direct line of steamers from Seattle taking the outside passage, and during the winter that port is icebound for about six months.

Attention should be called to the commanding position which Alaska occupies —guarding the North Pacific Ocean like a worthy sentinel. Due to the distance saved by sailing on the "Great North Circle," steamers on the Pacific-Asiatic run past close to the Aleutian Islands in their eastern and western sweep between the two continents—making American coaling stations, wireless stations, and fortified harbors, matters of considerable importance.

As my subject is primarily "Alaska Transportation," I will pass on to a brief description of one of the early transportation routes,—the immediate result of the discovery of gold in the Klondike in 1896.

By mid-summer of 1897 the value of this gold discovery was generally recognized and a northward movement began. While the gold seekers used many avenues of approach to Dawson and the Klondike in those early days, the shortest route lay over the Coast range of southeastern Alaska—which was approached by the Lynn Canal—thence over the divide to the headwaters of the Yukon River. The Lynn Canal is a long and narrow arm of the sea which extends northward at the upper end of the Panhandle. We have been asked the question as to when the Government expected to complete this canal but fortunately it was not the kind of canal that had to depend upon Government appropriations.

Only 20 miles intervene between the Pacific tidewater (at Skagway) and streams tributary to the Yukon, navigable for small boats. It is estimated that in 1898 about 25,000 people used this route into the interior and that upward of 35,000 tons of freight were transported over the arduous trails.

It was these conditions which led private capital to the construction of the White Pass and Yukon Railroad in the year 1898—the first railroad to be built in

Alaska. With its terminal at Skagway, it extends northeasterly for 110 miles to White Horse, the head of navigation on the Yukon, which point was reached by the railroad in 1901. With its auxiliary service of Yukon River boats, projected in the first instance to serve the Klondike gold rush, they made Dawson in 460 miles "river travel" down stream, and continuing a further distance of approximately 1,000 miles by river, they reached Fairbanks, the present northern terminal of the Government railroad, and the head of navigation of the Tenana River.

The journey from Skagway to Fairbanks by rail and riverboat, usually consumes two weeks and the route is used chiefly for high-class freight and passengers. Most of the heavy freight for Fairbanks is shipped to Mt. Michael by ocean vessels and from there transshipped by river steamers up the Yukon River.

Of other private railroad ventures in Alaska, three may be mentioned as influencing the Government Alaska Railroad. One of these was the Alaska Northern R. R. (Standard guage) having its terminus in Resurrection Bay at the town of Seward. It was started in 1907 and originally projected to the Matanuska coal fields (189 miles). The railroad was actually constructed by private capital for 71 miles, from Sewart northward to Kern Creek.

The Copper River Railroad was projected in 1906 to reach the rich copper mines located in the Copper River Valley. While this railroad had various beginnings by different promoters and from different terminals, such as Valdez, Katalla, and Cordova, it is sufficient for the purpose of this paper to say that it was primarily constructed by the Guggenheim mining interests to carry copper ore from their rich Bonanza Mine at Kennicutt—195 miles to seaboard at Cordova,—there to be transshipped to the smelters at Tacoma. This railroad was standard guage, with reasonable grades and curves, and was well constructed at a cost of approximately $25,000,000.

A government wagon road was built to connect Fairbanks with Valdez, also with Chitina, which latter point is a little town located at Mile Post 131 of the Copper River R. R., thus forming a transportation route from the south coast of Alaska to the navigable waters of the interior.

I have spent much time in this introduction in an effort to give a mental picture of the transportation problem in Alaska as it presented itself in 1912 and 1913 during the Taft administration.

Just who is responsible for the original thought to construct a Government railroad in Alaska I am unable to say, unless it is Judge Wickersham, of Alaska, who is sometimes given that credit. Early in 1900 the project was talked of, culminating in 1913 in the appointment of the first Alaska Railroad Commission, of which Col. J. J. Morrow of the Corps of Engineers of the Army, was chairman, and of which Dr. Alfred Brooks of the Geological Survey, and Mr. Ingersoll of New York, were members. This Commission visited Alaska in the late summer of 1913, and examined as well as very limited time and opportunity permitted, various routes to the interior of Alaska. They made no field surveys but collected such existing data as was available, and made personal examination of the country as far as time and opportunity permitted. From these studies a report and recommendation was submitted to the President early in 1914, and later in 1914 President Wilson appointed the Alaskan Engineering Commission to go to Alaska and make field surveys over certain designated routes.

Editor's Note.—The balance of the evening was devoted to lantern slides and moving pictures showing the towns of Seward, Anchorage, Nenana and Fairbanks. Also depicting the activities of railway construction and operation. The reels pertaining to the resources of Alaska were of unusual interest.

RAILROAD ELECTRICAL COMMUNICATION

By H. C. Chace*

Presented April 21, 1921

A number of the larger roads have for some time been using the single channel or duplex method, the output of which is somewhat in excess of a first-class Morse operated quadruplex. While the apparatus for the multiplex-duplex has not yet been available to railroads, I will make brief mention of its possibilities in railroad service, and especially between terminals where the volume of traffic is more than existing facilities can carry, and where additional wire construction would otherwise be necessary.

Printer operation means that a prepared tape, when passed through a transmitter at one end of a circuit, operates a typewriter mechanism at the other end, thereby printing the message the same as is done by a typewriter manually operated.

Each channel, being the equivalent of a duplex, provides for one sending and one receiving at each end of the circuit, the messages being transmitted simultaneously. By increasing the number of channels over a wire the capacity of that circuit is increased accordingly, with but a slight reduction in the speed of each channel, as compared with single channel operation, on which the speed averages from 40 to 50 words per minute in each direction. Between points five hundred or six hundred miles apart, as many as four channels are obtainable, or, in other words, there are four independent sendings and four independent receivings at each terminal over the same wire at the same time, the equivalent of eight circuits, which at 40 words per minute on each side of the channel would give an output of 320 words per minute over the four channel multiplex-duplex, or eight times the capacity of a single wire.

Printer operation is not of course confined to circuits of the length above mentioned. For distances up to 2,500 miles three-channel printers are in daily operation and since the recent introduction of the rotary repeater, two-channel circuits are regularly operated up to 3,500 miles. In printer operation, the skilled Morse operator is not required; his or her place being taken by a clerk, who perforates the contents of the message or report in a paper tape by depressing the keys of a keyboard which is somewhat similar to that of a typewriter. These clerks readily attain a speed in excess of the speed of the transmitter and have no difficulty in keeping the circuit loaded. Each letter, figure, punctuation, carriage return and line feed is represented by a certain character punched in the tape, which, when electrically transmitted to the distant end, performs its function of selecting on the typewriter the desired letter, figure, and so forth. At the receiving end an attendant is required at the typewriter to proof-read and remove the printed message. A roll of blanks automatically feeds into the machine.

THE CARRIER SYSTEM OF WIRED WIRELESS.

It appears that the greatest field for the future development of electrical communicating systems lies in the use of ultra-sound frequencies for carrying voice and other signaling currents over existing wires. The Edison phonoplex, in use many years ago on several railroad lines, was the beginning of superimposed systems and the pioneer of relatively high frequency signaling systems. However, the frequencies it and some of its successors employed were within the range of audibility and went into the discard with the growth of the telephone system.

Means have been found through the use of vacuum tubes of employing frequencies so high that they can produce no audible effect in the ordinary telephone

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receivers or telegraph instruments through which they pass. The success of the demonstrations using these high frequencies, so new to the wired telephone and telegraph art, has in the past three years upset a good many pre-conceived and orthodox notions of the limitations of telephone operation and engineering.

Under the most favorable conditions now known, it seems possible theoretically with two pairs of wires to carry on sixty independent telephone conversations and six or more additional telegraph communications without interfering with the present method of operation on the wires. In actual practice, however, but a few additional circuits have been thus far obtained, due to the fact that the system is yet in its experimental stage. As with other great inventions, many refinements will no doubt be made to simplify the apparatus and equipment required to gain additional communication channels over existing lines and to bring the installation cost to a point where the system will be commercially available to railways. Development work with the carrier system or wired wireless is being carried on by the signal corps of the United States army and by the American Telephone and Telegraph Company and tests have been made on one or two large railway systems.

TRAIN DISPATCHER'S LOUD SPEAKING TELEPHONE.

Train dispatchers find but one objectionable feature that is worthy of note to telephone train dispatching, and that is the necessity for the dispatcher wearing a headband receiver clamped to the ear continuously during his tour of duty, a practice which is irksome to a degree under the best of conditions, and particularly painful during lightning storms. Many efforts have been made to develop a loud speaking receiver which would eliminate this one objectionable feature, but in most cases with disappointing results.

Loud speaking telephones in train dispatching service, to be satisfactory, must be as dependable as the headband receiver, free from maintenance complications, have ample volume which can be readily controlled by the dispatcher, and clear in articulation.

Inventors of an electro-dynamic telephone receiver have, with the co-operation and advice of the telegraph and telephone engineers of the Santa Fe, developed a loud speaker which promises to meet all of the requirements.

The device is now being given a trial under proper test conditions. The articulation is free from distortion and such letters as S and F, T and P, heretofore so susceptible of confusion, are clearly reproduced. The voice currents are amplified by vacuum tubes. The apparatus is equipped with a modulator by means of which the dispatcher can readily regulate the volume of sound, reducing it for near-by stations and increasing it for distant stations, as desired.

OTHER SYSTEMS.

The wireless telegraph does not seem to have been developed to the extent it deserves, as it could be used to bridge over severe wire prostrations to a considerable extent, but even these advantages seem to have been availed of by but few roads. I believe this is a field which should be given intensive development.

The wireless telephone also gives some promise of utility on railroads, such as the bridging of interruptions and communicating with moving trains, but this system does not seem to have been developed to a point where it is practicable for railroad use.

There are other automatic systems which might be used by railroads, but their adoption is so unlikely at this time that further mention of them would be superfluous.

The systems most commonly used on railroads are the manually operated quadruplex, providing two sendings and two receivings, or four operators at each end of the circuit; the duplex, providing one sending and one receiving, or two

operators at each end of the circuit; the single Morse circuit, telephone dispatching and telephone message circuits, all of which telephone circuits may have a simplex superimposed on them for single line, duplex or quadruplex telegraph operation.

Where block telephones are in use, each of those circuits can be simplexed and converted into a single line, through, or way telegraph circuit.

If two metallic telephone circuits parallel each other and have been properly transposed, an additional telephone circuit known as a "phantom" can be obtained for operation between terminals. These phantom circuits give entirely satisfactory service.

Compositing of trunk telephone circuits, permitting Morse operation of each of the wires, is also practicable between terminals.

RAILROAD TELEGRAPH ORGANIZATION.

As the telegraph department is entirely responsible for the operation of the railroad electrical communication, doubtless a brief outline of the organization necessary for the proper operation and upkeep of the facilities will be appropriate at this time and serve to illustrate further the functioning of the telegraph departments usually found on large railroads.

Heretofore when asked what was most essential to provide a telegraph service, my reply has been that there were three requisites, viz., facilities, force and supervision.

Adequate facilities are necessary to good service and economical operation.

Sufficient force must be provided to render a satisfactory service.

Competent supervision is necessary; first, to plan facilities which will meet the requirements of the service and operate them economically, and, second, to see that the facilities are properly maintained and used.

The ideal arrangement is to establish general or relay offices, under the jurisdiction of one head at convenient points, preferably division and general office headquarters, so that each way office will have access to at least one general or relay office. These offices, forming the backbone of the telegraph service, must have a sufficient force to provide flexibility and this elasticity makes it possible to economize in the force at the less important offices without seriously impairing the service. It is a fact, known to all capable telegraph heads, that the one thing worse than not enough force is surplus force.

The relay office forces must be increased and decreased to meet changing business conditions, just as are train and engine forces, and in this the volume of business handled must govern.

ORGANIZATION.

In the Santa Fe organization the telegraph department is administered by the superintendent of telegraph, reporting to the operating vice-president. Assistant superintendents of telegraph are located at Topeka, Kan.; Galveston, Tex., and Los Angeles, Cal. A telegraph engineer, a telephone engineer and a construction engineer are also attached to the staff of the superintendent of telegraph.

A telegraph-telephone supervisor is located on each general manager's territory and is responsible for the maintenance of pole lines, circuits and equipment.

The locations of relay offices are selected with due regard to their convenience as wire testing stations. These offices are in charge of managers, who are considered representatives of the superintendent of telegraph in matters local to their districts, and they are responsible for their force of telegraphers, sub-chiefs and division linemen whom they direct.

These managers are experts in the electrical lines applicable to telegraph and telephone engineering, as well as resourceful in handling telegraph traffic, and they must possess sufficient executive ability to handle men successfully.

CIRCUITS AND CIRCUIT ARRANGEMENTS.

In providing and arranging telegraph circuits the object is to furnish each telegraph office with a direct wire to division headquarters and to at least one relay office, preferably and usually located at division headquarters and to connect the relay offices with each other for direct service wherever the volume of traffic warrants. Each relay office is connected by a direct and exclusive circuit to grand division headquarters and to such other relay offices as are warranted by traffic conditions, the object being to avoid manual relay with its attendant delay, expense and hazard of error.

The general office at Topeka, Kan., the largest on the system, has exclusive and direct circuits to each grand division headquarters on the entire system, and to all but two of the sixteen division headquarters on the Santa Fe proper, i. e., east of Albuquerque, N. M., and north of Purcell, Okla.

System headquarters at Chicago has an exclusive circuit to Los Angeles, Cal., and a number of circuits to the general office at Topeka, Kan.

The connecting circuits between relay offices are practically all quadruplex and duplex, the extra channels thus provided obviating the necessity for additional wires on the pole line.

The quadruplex is availed of wherever additional facilities are needed and can be thus obtained.

The main lines of the Santa Fe and many of the branches are equipped with telephone train dispatching circuits, and in addition have some independent telephone circuits used exclusively for railroad message work. Also, there are some circuits used exclusively for commercial telegraph service. These telephone circuits are all simplexed.

The bulk of the telegraph business is filed during the day hours and usually in such volume that the facilities are overtaxed, while at night those same facilities are practically idle.

With the exception of messages marked "rush" and those detected by telegraph office supervisory forces as being important, telegrams were, prior to the introduction of our classified service plan, transmitted in sequence of their filing time. As a consequence, important messages during periods of congestion and while waiting their turn occasionally were not given the service they deserved, while less important ones were moved more promptly than the subject required.

In order to correct this condition, more evenly distribute the traffic load and provide a more satisfactory and economical service, we inaugurated a classified service, which, in addition to the "Pink" service, provides for:

Preferred Service—For the handling of subjects requiring immediate and preferred attention.

Day Service—For the handling of subjects the urgency of which does not require preferred service.

Night Service—Where the delivery of the telegram on the morning following will answer the purpose of the subject.

No one knows the importance of a telegram as well as the sender or writer upon whom devolves the responsibility of designating its class, and the excellent co-operation we have had has made the plan an entire success.

Such officers as may be designated by the vice-president are authorized to use what is known as "Pink" service for extremely urgent telegrams. These messages take precedence over all business, except train orders and are given practically instantaneous service from originating point to destination.

The electrical communication facilities of a railway are open to use by the most of its employes and the ease with which messages may be filed for transmission would result in abuse if not controlled.

FUELS OF THE FUTURE

By S. W. Parr*

Presented November 10th, 1920.

In the first place, man used wood for fuel, and for certain specific purposes he may have found that charcoal was better suited to his purposes than the raw wood.

In time there were reasons which made it seem desirable to have a more intense fire, especially as the industries developed, the devastation of certain forests made it obligatory by law to stop using wood, and man went over to coal as a fuel. For certain specific purposes also he wanted it in a little different form, and made coke out of it.

We cannot follow that analogy too far, but along in the fifties,—'57, I think,—oil was discovered, which at the time did not seem to have any place in the industrial world as a fuel. But as time went on, it has assumed a very important place, and is playing a very important role as a fuel.

Somewhat the same thing can be said of gas. In Baltimore in 1819, or somewhere along in the early part of the century, and in New York a little later, gas came into the field, as oil did, as a lighting medium, with no thought of its being of any other use. At the rate of $10 per 1,000 cubic feet, which was the original price of gas in New York City, it would hardly be thought of as anything but a luxury in the way of lighting.

Now, what is to come of these two types of material which started out as lighting medium, or for some purpose other than that of a fuel? The future of these two types of material which are now coming into the realm of fuels is a thing which I hardly believe we can size up at the present time. Like any other large movement, we do not see it until the perspective has more fully developed.

I believe we are in a transition stage which at least is an exceedingly interesting thing to study, and this is the main thing I would like to bring before you. Possibly we may not be able to place ourselves off in some distant spot, and take what a college roommate of mine used to describe as a "bird's-nest view" of the situation.

Oil certainly as a fuel is here to stay, and it may be worth while first to look a little bit into the matter of oil as a fuel. I don't know but that we might formulate a statement to this effect, that the world now is demanding fuels which have the property of mobility. We must be able to carry it where we want it, push it or pull it or conduct it in some way to the spot where it is to be used.

I am almost inclined to go so far as to say that one or other of those types is the ultimate fuel. I do not know whether I am going to prove that proposition or not—perhaps it is better to put it out as a hypothetical statement. Anyway, I think the question is well worth discussing.

Now, what are the advantages in mobility? How have we come about this large use of oil, for example, as a fuel? Or if you are interested primarily in the gas industry, what connection is there between oil as a fuel and gas as a fuel, because I take it the ultimate purpose or ultimate use of both these substances will be in the main as fuels.

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Of course, you will revert back to the automobile and say that we have the automobile habit. But that is not the whole thing. It has somewhat of a parallel case in the matter of electricity. Electricity is power which can be put here or there or anywhere; put a motor where you want power and carry the current to it. So that the whole matter of habit does not reside with the automobile, but it has brought us along in the direction of locating the power where we want it. We take the power in our tanks and go wherever we please.

How about oil? The liquid fuels in other uses, as for example, in steam generation. I suppose the most striking use of fuel of that sort is in sea-going vessels. I happened to be in the port of San Francisco some five or six years ago, when the first vessel which had ever come so far west as this country, had not only left Copenhagen and come across, but had gone around the Horn, and came up the west coast to the Port of San Francisco.

The first striking thing about the vessel, and it was an average sized freighter of 4,500 tons, was that it had no funnels, and the question arose "Where is the steam mechanism?" I had the opportunity of going over the vessel. It was equipped with Diesel engines, but that was not nearly all of the story. I had the opportunity of seeing a cross-section of the boat, and the bunker space, which takes up such a large amount of the room in ordinary vessels, was nowhere to be seen. But in between the bottoms, the outer and inner bottom, and around in the curved spaces, where you never could put coal, of course, the oil was stored, space that otherwise would not be used for anything but space. And more than that, the vessel had steamed clear around to a southern port in California, and taken on oil, not because she needed it, but because she would need it before she got back home, came up to San Francisco, and was going back home with that one loading of oil.

I think you have seen statements somewhat to this effect, that an ocean-going vessel, the size of the Mauretania, requires something over 200 stokers simply to handle the coal, and the same boat equipped with oil-burning mechanism requires only about seventeen men, so the labor problem and the space advantage and the steaming radius, all these things are simply illustrative of the good things that accompany this type of fuel.

We might go on to enumerate the advantages of a liquid fuel,—efficiency in combustion and so forth, but I think we have found liquid fuel so admirably adapted for these uses that all the arguments are in favor of this type as opposed to a solid fuel.

What about the future? We are already using more gasoline than we are able to make in a year. And that does not begin to convey much of an idea as to where we are coming out in this matter. I saw a statement a few days ago of the automobile output of one particular plant, which perhaps leads all the rest in quantity, and the statement there was made that during the month of October one day's output was a little better than three a minute. Just figure this up in terms of gasoline. Three a minute means a certain draft on the year's supply of gasoline ahead of each machine. Each machine is run, I suppose, 4,000 miles a year—that is not too great an estimate for a flivver per year, is it—but if it is 4,000 miles, that means, not crediting it with too many miles per gallon, we will say 200 gallons of gasoline per year.

And if there were three of them in a minute, that is roughly 30,000 gallons per month or say 300,000 gallons per year. You don't need to be very much of a mathematician to see that the gasoline requirement is something like 60,000,000 gallons for the year's output. Of course, some of them are wrecked and they are not all using perhaps a full quota, but the amount of increased demand for gasoline on this account alone would practically double the requirements in about twenty-five years, so that if we are using now something less than 2,000,000,000 gallons a year, the increased demand on this account alone within the next twenty-five years will require about 4,000,000,000 gallons.

Where is this gasoline going to come from? There are quite a number of interesting problems connected with it. First and foremost, the chemists are sitting up nights trying to find out how they can make more gasoline out of the oil that is at hand.

Take another illustration, the total output of petroleum in this country at the present time is something like 340,000,000 to 350,000,000 barrels. It does not all go into gasoline, by any means; only a very small percentage, less than 12 per cent of the total petroleum yield is convertible into gasoline. There are some oils that will yield as high as 40 per cent, perhaps, of gasoline, and which lend themselves more readily to the process of cracking or reverting to the lighter forms, but as a whole, taking all the oils of the country at large, the total amount of gasoline that is made under present practice is only about 12 per cent.

So you see the chemist has quite an attractive field; if he can increase the total gasoline recoverable from petroleum by even 2 or 3 per cent. So ultimately, if we look at all the flivvers, and near flivvers, and figure on the demands that are bound to be made upon the volatile type of oil as a fuel, and if all the oils which are of interest now to the gas industry are utilized for the making of gasoline, I hardly see where the gas man is going to have a look-in very long on that type of supply.

There are some hopeful avenues that the chemist has open to him. The amount of hydro-carbons in the form of oil is limited. There is only about so much, and it can last about so long, but alcohol is available. That is, the potential yield of alcohol is without limit, but the agriculturalists will need to be enlisted in the cause. Alcohol itself is not a very good automobile fuel, but alcohol with benzol or such combinations as alcohol and ether are being studied with hopeful results. Gasoline and benzol or gasoline and benzol and alcohol, all those mixtures are not only potentially available, but some of them are actually in use.

But even so, I am inclined to think that gasoline is the base for most of these motor fuels, and will still be in high favor, and the chemists will get so far along in their ability to transform the heavier oils into gasoline that I believe if I were in the gas business I would ultimately expect that this source of supply for gas enrichment might disappear entirely.

Of course, five or six years ago it looked as though gas oils were reaching the point where they could not be touched on account of price, but new oil fields were discovered, and we became complacent and things became easy again. So this fluctuation up and down is bound to continue, but the demand for fuel of the fluid type for steam generating purposes or in Diesel engines or in engines of the Diesel type, or in engines of the automobile type, is bound to continue, and increase, and must be met.

So much for that type of mobile fuel, which is of the liquid type. What about gas? I think I have said before on certain occasions, at least it is not anything especially new, that gas which originally was purely a lighting proposition, will ultimately be used primarily as a fuel. It may be difficult to substantiate a proposition of that sort at the present time but even so far back as 1885, I think it was Sir William Siemens, made a statement which is familiar to all of you doubtless, sort of a confirmation, I think, of this idea, when he said that he was "bold enough to go so far as to say that coal in the raw state should not be used for any purpose whatsoever," and that the most judicious and economic thing to do was to convert it either into a gas or into gas and coke, as is done in the ordinary coking process.

That was a long time ago, and the idea has become somewhat obscured, but I believe it is coming to the surface again. Even as late as last year a prominent French fuel authority advocated that legal measures be instituted for prohibiting the use of fuel in the solid form for any purpose, but that it should be converted into gaseous form, and used in that way. You might say that he was a Frenchman, and he had the art instinct strongly developed which was at the bottom of that propaganda. Not so at all. His argument was along the lines of conservation.

If we were to go into the calculations, it would not be very difficult to show that, starting with coke on the one hand, burning it under a boiler, we will say, and converting it into steam, the same coke converted into gas, because of its greater efficiency will deliver an equal or even greater amount of power than the original coke from which it was made.

Take another illustration. I put a ton of coal in my bin last week, and I was a little interested in figuring that for $10 I got approximately 20,000,000 B. T. U. My town is a little higher priced in the matter of gas, but for $10 worth of gas I get a little more than 6,000,000 B. T. U., and if these two things were to come as near together as in the ratio of 20 to 10, which is not a very large jump, there are lots of things that we would use gas as a fuel for, not only to far greater satisfaction, but as a matter of economy.

So I say that we are rapidly approaching a time, it seems to me, when gas will really begin to take the place of solid fuel for many purposes where solid fuel is now considered the only fuel suitable.

There are a number of things which, from the economical standpoint, are pointing along these general lines. I don't know, however, whether we should go into these questions which are more or less chemical in nature. But here are a few things bearing in that direction. I believe we are only just beginning to understand some things, not only about gas as a fuel, but about gas in general and the manufacture of it. I have said before, and the more I see the more I believe it is true that the gas industry has contented itself too long with a study of mechanical devices. There are a lot of different kinds of retorts, or we may develop an entire system of by-product ovens as distinct from the old gas retort, because we can do it more economically on a large scale, and we will devise methods of handling, of loading and discharging, and all that sort of thing, and this has been the sum total of the development in the gas industry.

It is true that some large gas interests, like those of New York, have been pretty closely in touch with chemists all along, but as a rule the industry as a whole has stood these hundred years, almost exactly where it began, distilling coal and taking what you can get out of it as gas.

Now, let us see some of the errors that have come along from that purely mechanical method of handling coal. In the first place, the ordinary gas retort, the D-shaped retort, carries a temperature of 1,000 degrees centrigrade,—1,800° Fahrenheit,—the coal passes through this heated area, and we get a gas. We have been fairly well satisfied with it. The by-product oven does exactly the same thing. It is not the product of decomposition of the coal at all. I doubt if there is anything that initially comes off the coal that is the thing we get and call gas at the end. Numerous secondary decompositions have taken place and destroyed a lot of values. The coke we have at the end is not very good coke and a lot of us who have to burn the gas don't think it is very good, either, and then there are a lot of tars that are also not very good.

Then we take the coke and make it over into water gas. That is largely a mechanical development. Is this the best way to do it? Well as to quality it will do pretty well if it will average 550 units, perhaps, per cubic foot. The initial gas that comes off from coal in the process of decomposition will run a good deal better than 800; it is not unusual for it to run about 900. If we could keep that gas from spoiling in the subsequent process we would have made some progress. You say that is a chemical problem. It is only one of a good many chemical problems that are unsolved.

If the oil is going from us, possibly the theoretical, the logical thing to do is to make a lean gas and leave the oil out. Practically the only thing the oil is in there for is for enriching or for making a gas to conform to some standard, some public utility standard or city ordinance, or to meet a candle power condition. When we understand these things completely, doubtless we will come to a heat value which will have some logical connection with the conditions under which the gas should be made. I don't know whether we will live to see it or not, but there are a good many indications from the theoretical standpoint why 500 or 450 heat units per cubic foot would solve a lot of these questions which are chemical in their basic meaning. If we can't get oil, and can make a gas just as well without it, which would be of less heat value, 450, for example, why not make that kind of gas, if it can be made cheaper. These are the lines of development which we are doubtless obliged to look forward to.

Somewhat along this general line there are one or two things which we are very much interested in at the University of Illinois, and one especially is in the manufacture of gas and the utilization of coal. All that I have said might be an argument for some things that we hope to see established, and that is a laboratory where these things in their more chemical phases might be studied and possibly solved.

I am especially interested now in some work we have been doing which may bear a little on some of these lines, and I will take a little time to discuss them.

If I had a chart here of the output of coal in the United States, it would show along the anthracite curve an almost uniform output. Along in 1902 there was a sharp drop in the output. That drop was due to the great anthracite strike of 1902. It seems to some of us that since Illinois has a lot of coal, and the anthracite coal is going to give out some time, would it be possible to take the smoke out of Illinois coal,—not make an anthracite out of it,—but make a fuel which would be smokeless? That was the initial starting point of this work that we have been doing. That work has been going on, and oddly enough, some of the experiments, some of the very simple experiments that were tried, even in that same year, in a

900 B. T. U., or will average say 750 units per cubic foot. So much for the oil rough and ready way, you might say, to get a lead on what to do with Illinois coal, have proved to be the ultimate solution, if you may call it a solution, of the problem.

We did not know just how to interpret them at the time. We have kept some of these peculiarities in our vision all of this time, however, and now we think it is possible to make a fuel out of Illinois coal which is smokeless.

But that is not the main idea which appeals to me. In this broader view of what is happening to our fuel, we get a high percentage of the liquid type of fuel. That is to say, 20 to 25 or 30 gallons of the oil which will fill that need for the liquid type of fuel. I don't mean that it is gasoline, by any means, but it is of the type of petroleum oil, half a barrel, we will say, to the ton.

The gas, moreover, is of this very high-grade variety which will run 850 or on one hand, and so much for the gas.

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TECHNICAL PAPERS

Coal Mine Power Transmission

Presented by W. C. Adams,* April 25, 1921.

The increasing use of electric power in the coal mining industry makes necessary a careful study to determine the most efficient and practical methods of underground transmission under the unfavorable conditions that generally exist in bituminous coal mines. The requisite of a properly designed transmission system is the same for all mines; namely, the furnishing to the operating motors power at a potential suitable for the efficient operation of the motor and machine which it drives. The factors required as a basis for designing a transmission system are dependent upon the physical conditions of the mine, the mining system, the operating system and conditions and will vary with different mines. The factors and any rules given in a discussion of underground transmission in general must therefore be considered as covering average conditions existing in any one mine. An attempt has been made in this discussion to give factors which will apply to the average conditions as found in bituminous coal mines operating on the room and pillar or panel system which will vary in same details from the factors applying to transmission for mining on the long wall system.

The introduction of motor driven equipment for cutting, loading, gathering, hauling, hoisting and preparation of coal and for pumping and ventilation in these mines has made the application of electric power possible for practically every operation in the production of coal. Of these cutting, loading, gathering, hauling and pumping are "underground" operations, dependent upon the underground transmission for power.

The majority of the machines used for these operations are equipped with direct current motors, although alternating current induction type motors have been developed for some types of equipment.

The locomotives used for mechanical haulage are almost universally equipped with direct current motors. Some alternating current motor equipped locomotives have been used but their application in mining service is limited.

Gathering locomotives are of three types, all of which are equipped with direct current motors. Of these types, the trolley locomotive with cable extension for furnishing power to the locomotive when operating in rooms is the most used. Under favorable physical conditions and mining system storage battery locomotives may be used to good advantage. The third type that would be considered is a combination of the trolley and storage battery type, the locomotive being designed to take power from either the trolley circuit or from a storage battery mounted on the locomotive itself.

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The coal is cut generally by chain machines of the breast, short-wall or the arc wall type, depending upon existing mining conditions. A cutting and loading machine is being developed but as yet it has not come into practical use. The direct current motor driven chain machine is used in the majority of mines equipped for mechanical mining, although the alternating current motor driven short wall machine has some advantages such as more even cutting speed giving greater production, better efficiency and less motor troubles. The principal disadvantage in the use of the latter type is the fact that it requires in most mines two distinct transmission systems.

Loading machines are a recent development and are not extensively used in any field, although they have been installed in a few mines in the eastern fields.

Pumping equipment may be driven by either direct or alternating current motors, depending upon the character of the available power or their location in the mine.

Few mines have, on account of physical conditions or for economic reasons, been equipped for mechanical performance of all of the underground mining operations but with proper application electrically driven mechanical machines have been almost universally successful both practically and economically. Where trouble is experienced with their operation it can often be traced to the lack of proper transmission system supplying the power to the motors. Many systems are started by installing a four naught circuit which serves until the motors cease to run and then another four naught is added and so on.

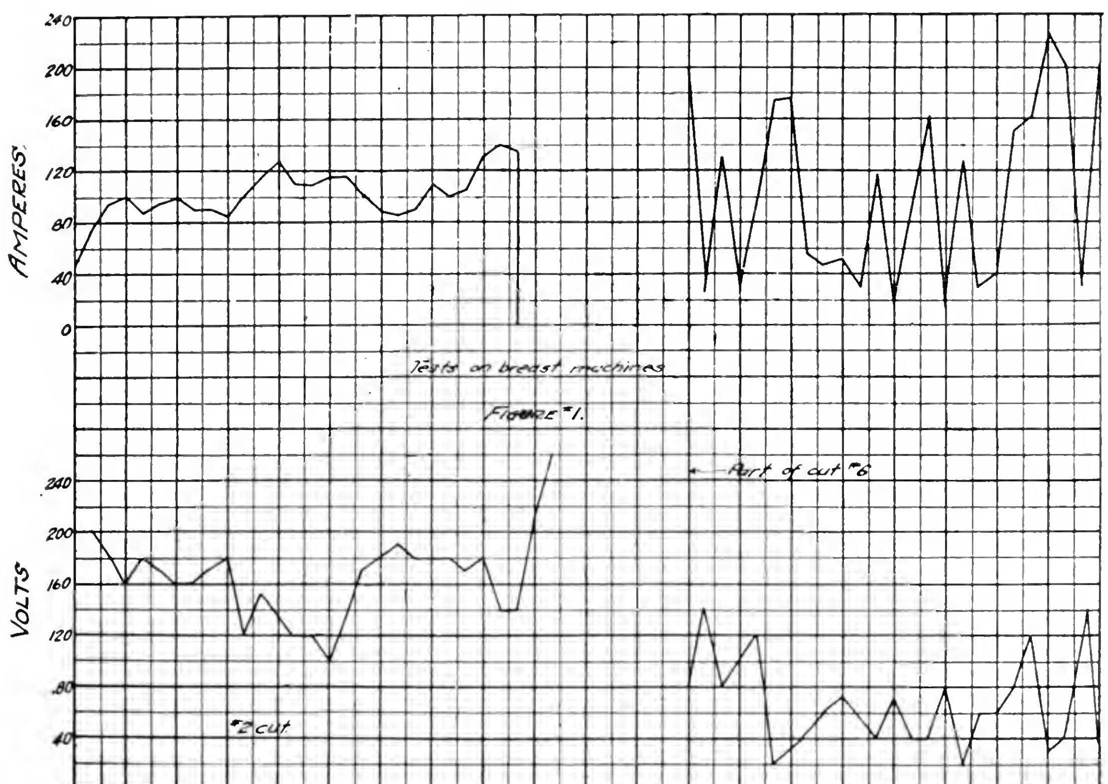
Improper power transmission not only effects the cost by reason of the power losses but the resulting low voltage conditions decrease the efficiency of the various machines depending upon electric power for the production of coal. Figure No. 1, gives curves showing a comparison of the ampere and voltage curves taken on a breast machine when making the second and a part of the sixth cut in the same room. The second cut was made when very little other equipment was in operation, while the voltage during the sixth cut was influenced by other equipment operating in the vicinity.

A comparison of the second cut, Figure No. 1, with the fifth cut, Figure No. 2, shows the effect of low and varying voltage conditions. The average voltage for the second cut was 154.2, average amperes 100, time for making cut four minutes twenty seconds. The average voltage for the fifth cut was 108.8, average amperes 106, time for making cut eighteen minutes. Further analysis of the curve, Figure No. 2, shows the continual operation of the clutch which was necessary to prevent the machine from stalling and also the acceleration power caused by the varying of the voltage over wide limits. The curves, Figure No. 3, show the relation between average voltage during runs to the average amperes, time of making run and watts per square foot under cut, hours at the machine, all as calculated from tests taken on breast machines in one mine. Similar results are obtained on other types of mining equipment under varying and low voltage conditions. Such reduction of the speed of cutting, gathering, hauling and other mining equipment makes it necessary to use additional machines to maintain tonnages which aggravates the situation. The low voltage condition giving lower operating speeds and increased operating time results in excessive heating, causing failure of armature and fields of motors.

In the development of proper transmission systems for bituminous coal mines each has to be laid out to meet the specific conditions that exist or are anticipated. All of the mining equipment with the exception of the haulage locomotives operate at the face a distance from the source of power and with the development of the mine this distance is continually increasing. The continual receding of the working places causes a constant change in voltage condition.

In installing or making changes in transmission systems it is therefore usually advisable to base the system on the needs for the period of three to five years following, using the projected working of the future mine developments for a basis of calculation. This avoids the necessity of making frequent changes or reinforcements in the existing feeders, the advancement being taken care of by the extension of these feeders.

The average mine underground workings are divided into sections with centers to which the coal is gathered, located a various distances from each other, this distance being dependent upon the mining systems used and the advancement of the development. The transmission system must be such as to provide a suitable voltage to the machines operating or are expected to operate in each section to produce the anticipated section tonnage.



Proper consideration must be given to the character of the machines installed, the physical conditions of the coal and mine, the demand factor, maximum loads and their duration.

Where a mine is developed to its maximum tonnage and various sections are equipped with their normal quota of coal producing machines, it is possible to secure the average maximum sustained demand by actual readings. This, however, could be obtained accurately only by the use of recording equipment over a considerable run since the demand conditions vary considerably, being dependent upon the rate of coal production at the face.

The maximum demand of any mining sections where locomotives, mining machines and other mining equipment are operated may be taken as the average demand over several periods in which the haulage locomotive in addition to other equipment is operating in that section. If the locomotive is not the determining factor the

maximum sustained demand may be based on the average of five minute maximum demand periods.

Where it is not possible to secure this information from the actual performance of equipment installed at the mine for which the transmission system is being laid out it is necessary to base the calculations upon conditions existing in similar operations.

In considering direct current transmission for two or more classes of mining equipments taking power continually direct from system, mines using main line haulage locomotives with trolley gathering locomotives and cutting machines, main line haulage locomotives with gathering locomotives must be considered. In general the rated capacity installed for gathering locomotives and mining machines have about the same relation to the tonnage. Under average mining conditions the average power requirements for cutting and gathering are about equal and the average maximum demand for these two operations have about the same relation to the total connected load. The same maximum sustained demand information can be used as a basis of transmission requirements of each of these three combinations.

Information which would give an absolutely accurate basis for calculations under all possible varying mine conditions must necessarily come from tests in mines with the same physical and operating conditions. This is impossible, as there are no two mines alike in this respect. An average of results obtained from tests when used as a basis for calculation of other systems and proven satisfactory should be taken as sufficiently accurate for practical purposes.

Such information on direct current loads consisting of haulage locomotives with cutting or gathering locomotives or a combination of the two which is the result of numerous tests at various mines and under varying conditions is embodied in a curve as shown in figure No. 4, giving the average ratio of the maximum demand to the sum of the rated demand of the various units installed.

In most fields there is no choice of voltage, since the state laws have limited the potential permissible on power wires or exposed current carrying parts. This voltage limitation in the several coal mining states varies from 275 to 310.

For such systems 220 to 230 volt direct current motors are used and generator voltage is held as high as permitted by law. The efficiency of the motors used for driving the mining equipment will not exceed, in many cases, 75 per cent, so it is possible to assume one K. W. demand per rated H. P. The ampere curve, as is also shown in figure No. 4, is the average of test and the ratio curve is calculated from this, using the generator voltage of 275.

There may be variations from this curve due to heavy grades or exceedingly hard cutting. In laying out a transmission line where one or both of these abnormal conditions exist, an addition of five to seven per cent for either should be made to the rated demand, provided these abnormal conditions have not been taken care of by increasing the capacity of motors used with the equipment.

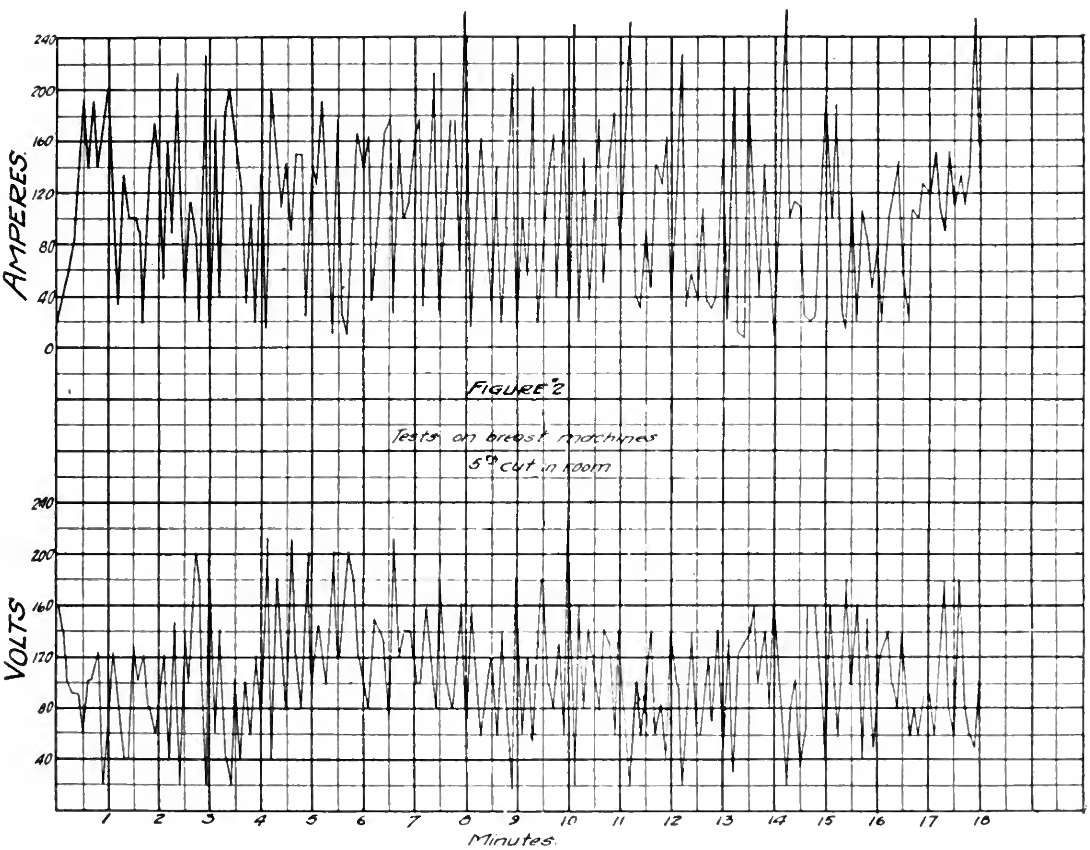
Where combination locomotives are used a different condition exists, and one-half of the rated demand when operating on transmitted power should be added to the remaining load to secure the total rated demand. Where the combination locomotives are arranged for charging when operating on the transmission system, one-half of this demand should be added.

With voltage limitations and transmission distances as exist at most coal mines it is not economically feasible to lay out a transmission system along the lines employed for industrial plants where a definite power loss of say 10 per cent is allowed.

In coal mines it is often permissible to allow an average loss of from 20 to 30 per cent, and the system is based not on loss but on securing a definite operating voltage under average maximum sustained demand conditions.

The average power demand for like units does not vary materially in different sections or in different mines unless due to a variance of physical characteristics of coal or mine. It is probable, therefore, that where the ratios between the connected and average maximum demands are high that the period of maximum demand is short and only a small percentage of the total operating time. It is, therefore, permissible to allow a lower voltage under such conditions and still secure a fair average. The permissible voltage drop, therefore, to the various section load centers where mine equipment is operating is dependent upon the ratios as determined above. The resultant voltages allowable at these loading centers may be taken approximately as shown by curve in figure No. 4.

It is desirable to have a separate feeder circuit to each section independent and controlled by a full automatic circuit breaker. This makes possible the cutting out automatically of one section of the mine in case of trouble of shorts, overloads, etc.,



without interrupting other sections. In some mining systems this method is entirely impractical on account of the costs. It should, however, be the policy, where possible, and if it is necessary to make one feeder serve for two or more mining sections a ratio between the maximum demand and the sum of the rated demands of the connected units may vary slightly from the above curves as shown in figure No. 4, depending upon the operation of the haulage locomotives. Figure No. 5 gives the average maximum demand ampere curve of combined sections.

The above curves apply to mines using mining machines, haulage and gathering locomotives, loaders, etc. Where entry driving machines, large continuous fan or pump motors or other equipment having a higher demand factor are used these loads should be considered as an addition to the other mining equipment maximum

demand. This equipment does not have a fixed relation to tonnage and it is, therefore, impossible to give any reliable information as to the probable maximum demand where they are used.

Where entry driving machines or other continuously running direct current motors of 30 H. P. and above are used, the minimum voltage under average maximum demand conditions should be not less than 210. With continuous running equipment with motors of less than the above H. P. are used, the voltage as low as 195 may be allowed under maximum demand conditions, provided the equipment is over-motored or especially designed for that voltage condition.

Where the mine is equipped for main line locomotive haulage only the trolley, feeder and return system should be based on a demand of 125 per cent of rated connected load that is under ordinary operations working on a given section or sections as determined by the probable locomotive schedule.

A voltage of 175 to 180 is permitted at the parting with this load under ordinary conditions. If severe grades are encountered at the start this voltage should be increased by at least ten.

The circuits from the load centers to the working faces when motors are operating should be of a size to give a voltage drop not greater than 10 volts.

The basis for calculation of the proper transmission system for an existting mine with its underground workings developed to maximum can be determined, therefore, by the connected load used with the above curves. When the mine is not developed or has not its full quota of mining equipment the connected load can be estimated after determining the number, size and location of the various types of running equipment that will be required to produce the required tonnage based upon the projection of the contemplated mine development, the thickness of the coal, size of car to be used and the various other factors entering into the determination of size of mining equipment.

With the maximum demand and the desired voltage obtained for the various sections the size of the conductors required can be obtained by the formula $A=22\ dI/e$. Where d equals the distance from the central distributing point to the load centers I equals average maximum sustained amperes, e equals generator voltage minus voltage desired at the load centers. A equals cross-section of copper in circular mills.

Properly bonded and cross-bonded track can be considered as its equivalent of copper sections, but where necessary it should be reinforced by a copper conductor. Where bonded track is taken into consideration as a part of the return circuit, special care must be used to maintain the bonding highest efficiency.

Where it is desired to have one circuit act as a feeder to two or more sections over a part of the distance the resulting voltages over an assumed single feeder circuit to all sections to be served by that common feeder calculated as above should be determined for the various junction points.

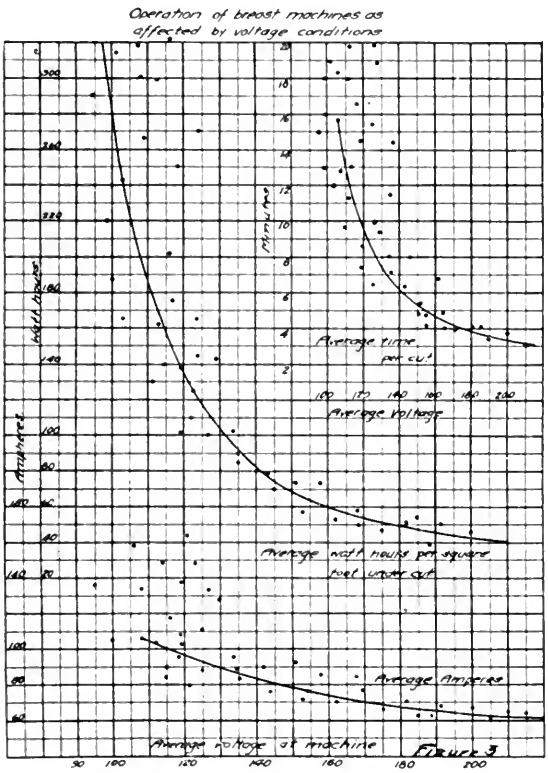
The highest voltage at any one point is usually used in determining the voltage drop for a base of calculating the size of the common circuit. Where voltages at the junction point vary considerably and in the development of the mine are likely to continue to vary, an average can be used making an adjustment in the circuits from the junction points to the load centers to secure the desired voltage.

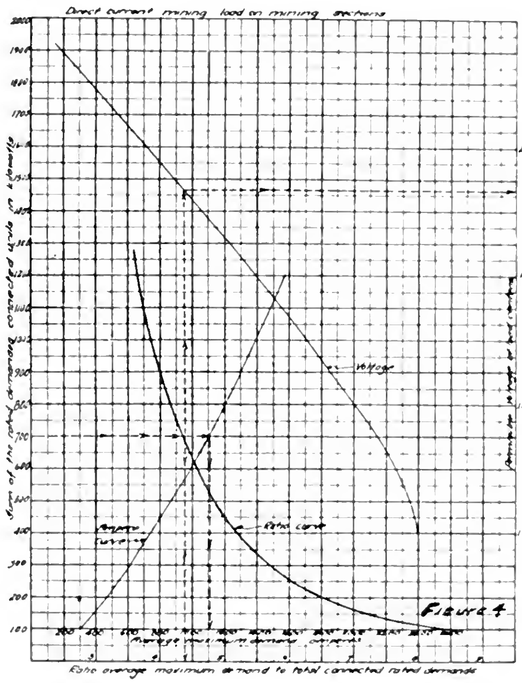
A direct current transmission system design on the above basis gives satisfactory results for small and medium sized mines and can be installed with a reasonable expenditure. The cost, however, of such a system for the larger mines becomes prohibitive. The power distributing systems for these mines, having large capacities and large assigned coal areas, should employ alternating current at the proper volt-

age for transmission of power to the load centers, with equipment installed at these points converting to direct current for distribution to the various operating points.

The determining factor in the choice between direct current and the combination alternating and direct current systems is the cost of installation and maintenance. The basis of calculating cost for either systems should be the ultimate expenditure required in working out the assigned area. In the case of existing mines generating their own power as direct current the cost for comparative purposes should include the expenditure necessary for making the necessary change in power plant equipment or making the necessary arrangement for the purchase of power from a utility company, provided such power is available and investigation justifies its purchase.

With such a system, the cheapest and most satisfactory means of transmitting alternating current power is by surface pole lines entering the mine by cables sus-





pended in bore holes at or near the contemplated sub-station location. The alternative method, provided underground transmission of high voltage is permitted by law, is to enter the mine through one of the main openings and carry the transmission cables along the entries to the converter station. With such systems every care should be taken to prevent possible injury to man by carrying the cable along an untravelled air course, or entry, by using a conduit system or by using submarine cables laid in the mine floor.

The underground sub-station should be installed in a fireproof room, properly locked to prevent entrance by unauthorized persons. This room can be properly ventilated by placing the sub-station between the in and outgoing air circuits and making proper ventilation connections.

The number of converting units required must be governed by the mine development, but the numbers should be reduced to the minimum possible without necessitating excessive lengths of direct current distributing circuits. This can often

be accomplished by combining two or more sections carrying the connecting cables along room entries between the parallel cross or main entries, having each section on a separate feeder from the sub-station and controlled by a full automatic circuit breaker. Where room entries are driven to a fire pillar this should be drilled, drill holes cased and armored cable used through the hole with one end sealed to prevent air connection. By combining sections in this way it is possible to reduce the total converting capacity to a minimum and increase the demand factor, thereby securing the best operating efficiency.

These converting units should be located as near as possible to the load centers but should in every case be on an entry that would be maintained in the ordinary development of the mine and convenient for inspection and operation.

Where it is intended that the converting units be manually operated it should be located so that it can be readily attended by a man on other work, such as tripping switches or other similar duties. A unit so operated should have automatic protection on an alternating current against excessive loads or excessive reduction in voltage. The direct current side should be controlled preferably by a full automatic circuit breaker with such protective features for parallel operation as may be necessary. In some cases it is advisable or even necessary to incorporate automatic load limiting features to prevent excessive overloads which might be imposed by units operating close to the converter station.

There are many of the converting units installed operating in this manner and giving satisfactory service, but this system lacks the element of insurance, and to provide this automatic control for converting units is recommended. Such a control should provide automatic starting and synchronizing, opening of primary switches for failure of voltage or excessive overload with restarting features or return of voltage or time limit restarting features if stopped because of overload. Control should give protection on direct current and for overloads by a full automatic circuit breaker. Automatic protection should be also provided against hot bearings, over speed, reversal current, overheating of windings and single phasing. In most installations and especially where two or more sub-stations are cross-connected it is advisable also to provide load limiting production. Where converting equipment is used with very long haulage systems giving periods of practically no load conditions at the sub-stations for appreciable periods of time it may be found advisable to include automatic features for controlling the operation with respect to that load.

In laying out the direct current distributing system from these converting units to the face the same method as already described is used. It is usually possible, however, to increase the voltage to the load centers from five to ten per cent above the values previously given and justify the additional cost by the power saving. The same allowable voltage drop of ten volts between the load centers and working places will apply.

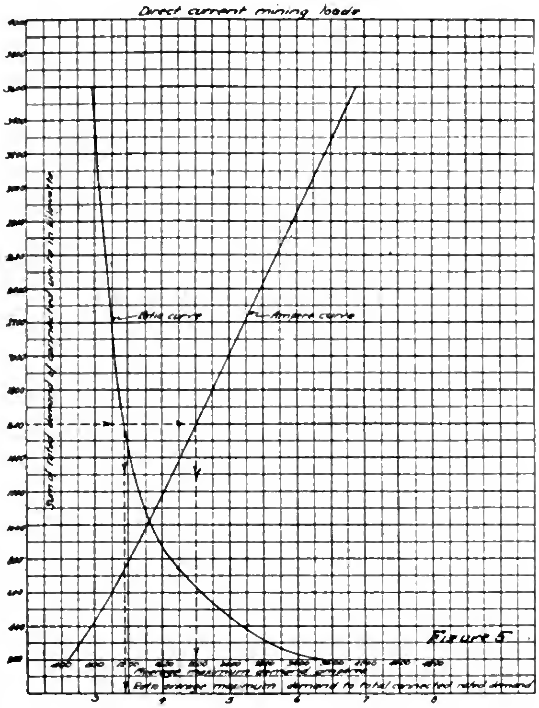
The size of the converting equipment required is determined by maximum peaks, maximum demand and average demand at the load centers. The maximum demand is determined on the same basis as used for transmission circuits. It is usually permissible, however, where the equipment is rated on 40° C. rise basis to install a unit of rated capacity below the average maximum demand. Figure No. 6 shows curve giving the size of converting equipment required in relation to the sum of the rated demand of the connected equipment.

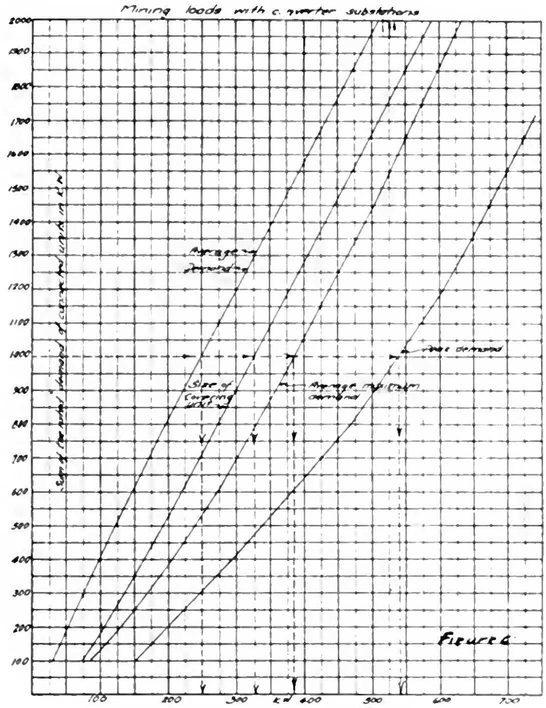
If the rating of the equipment used is based upon other than 40° C. rise, proper connections should be made in determining the rated capacity of the converting unit required. This capacity curve is based on the average and maximum demand conditions that will probably exist with a given connected demand, as also shown in

figure No. 6, and the assumption that units rated as above will carry momentary loads to 200 per cent of rating. Irrespective of the rating, however, the converting unit should be capable of handling momentary overload, as shown in figure No. 6, without injurious heating or sparking.

These converting units may be either synchronous converters, synchronous motor generators or induction motor generators. The choice between these types is dependent upon the condition of load demand, the operating conditions, efficiency, power factor conditions and personal preference.

The use of an induction motor generator, however, is not usually advisable on account of its inherent lower power factor. Practically all utility companies insist on synchronous equipment being installed wherever possible in order to maintain





power factor conditions, and this type of converting unit is preferable for the same reason where power is generated at the mine.

Some systems having an abnormally high percentage of inductive load with most units over-motored, some method of power factor connection is desirable. Additional condenser capacity can be furnished in the synchronous motor of the converting unit, thereby securing the desired results at a minimum cost. Where the supply potential is fluctuating and subject to periods of abnormally low voltage or where the demand is such as to cause sudden excessive load fluctuations the synchronous motor generator would prove an advantage owing to the fact that it is more staple.

The character of a mining load at separate converter stations is such that the converting units are operating at fractional loads a great deal of the time, therefore the efficiency at fractional points of rating is very important.

Figure No. 7, giving the comparison of the efficiencies of the two types of equipments for 300-KW capacity, shows a difference at one-quarter load of 14.6 per cent at normal load of 4.4 per cent, and the no load loss for the synchronous converter is 10-KW as compared to 38.4-KW for the synchronous motor gen-

erator. In operation on a load having characteristics of a mining load the synchronous converter will show a material saving in power consumption. In actual operation for monthly periods synchronous motor generators have shown efficiencies from 62 per cent to 70 per cent, while synchronous converters under very similar service have shown monthly period efficiencies of from 78 per cent to 87 per cent. While under the most favorable conditions these period efficiencies may be better, the saving of synchronous converters over synchronous motor generators is rarely less than 12 per cent.

The above comparison of efficiency is on the basis of 100 H. P. operation of the units and with the usual proportion of inductive load found at coal mine installations this is sufficient to maintain a power factor on the system of from .90 to .95.

Under average normal conditions as found in coal mines the synchronous converter will give satisfactory operation and is much to be preferred on account of the better efficiency, especially at fractional loads, and unless the synchronous motor generator is desired for its condenser characteristics the synchronous converter should be recommended.

The alternating current transmission system is designed on the basis of the average maximum demand, as shown by curve, figure No. 7, making suitable allowance for converter efficiency and for any additional load carried on the same system. The voltage is determined by the transmission distance or by existting power supply lines or power sources but should not be less than 2,300 volts.

The transmission system for furnishing power for the use of alternating current short wall mining machines requires high voltage be brought into the mine by a method similar to those described above, transformer sub-station placed at the load centers reducing the voltage for the secondary transmission to the working places. The transformers should be of proper ratio and provided with sufficient taps so that the normal secondary no-load voltage is as near 275 as is practical.

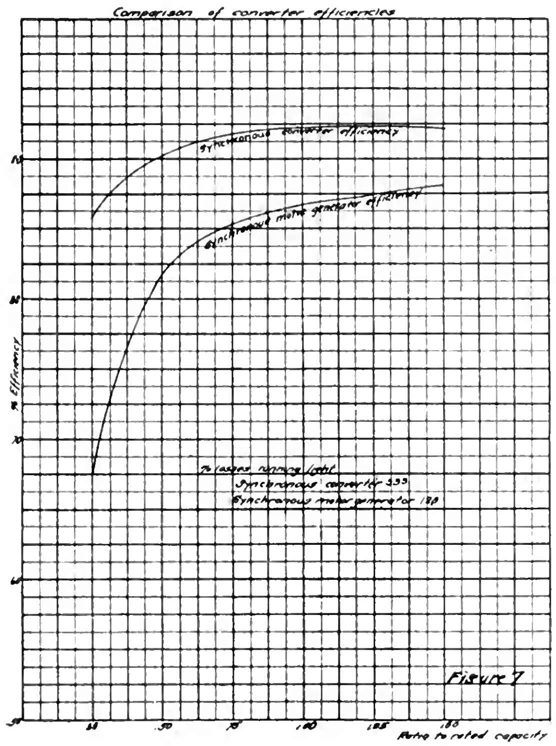
The circuits should be designed to give a potential of not less than 215 volts under average maximum demand conditions at the machines. The proportioning of the loss that is permitted in the primary or secondary of the transmission system is determined by balancing the cost and is dependent upon the length of the secondary transmission required. The primary loss should be kept as low as practical to reduce the sizes of secondary cable required, and 3 per cent is recommended where alternating current machines and converter equipment is used the high voltage transmission line can be designed to serve both systems. The size of the transformers are determined by the average maximum demand and curve; figure No. 8 shows test averages in percentage of the sum of the rated connected demand for varying numbers of machines. Based upon the above demand curve the size of transformer stations recommended is shown by the capacity curve, figure No. 8, in per cent of rated connected demand.

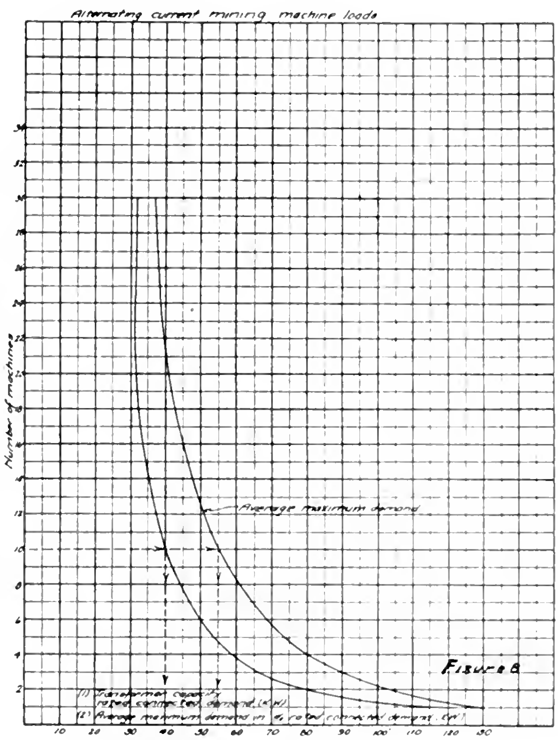
As far as possible the transformers throughout the mine should be of the same size to permit interchangeability. By proper determination of these sizes it is usually possible to provide for any section by using two of three transformers to a section. As a safety and protective measure the transformers should be placed in fireproof rooms properly protected and ventilated.

In considering power transmission problems for special cases it is usually found that except for the smaller mines a considerable saving in initial investment can be made by the adoption of the alternating current and converter system for underground work, and at the same time secure better efficiencies and operating conditions. Often the installation of such a system is handicapped in the case of existing mines by the fact that the power plant is already developed for furnishing direct current power. In considering new properties, therefore, the proper system of

underground transmission should be determined before any decision is made as to the power to be generated.

In considering existing mines it is often possible to satisfactorily take care of the transmission problems by a combination of the systems, replacing only a part of the generating capacity by alternating current units and operating either independently at the station or with a balance unit. This would particularly apply where only a part of the mine is to be developed to a point to give excessive direct current transmission distances. It is, however, impossible to give a general solution for problems involving existing mines having direct current generating stations and each has to be decided on the basis of its particular conditions.





DISCUSSION

GRAHAM BRIGHT*—Mr. Adams shows very clearly the advantages obtained by having good voltage regulation in the mine circuits. I do not believe that he has laid enough emphasis upon the large increases in repairs caused by low voltage. The curves given in plate No. 3 are a revelation and show in a remarkably clear manner the large increase in time and power consumption which takes place with poor voltage regulation. The two upper curves giving the increase in time and increase in power consumption should be sufficient to convince any operator that it is particularly bad practice to operate at a voltage less than 160 volts for either cutting or locomotive service. If this curve were applied to the test shown in plate No. 2 it would indicate extremely poor economical operation. If another curve could be added to plate No. 3 showing the increase in cost of upkeep as the voltage is lowered, it would be of considerable value, but it is doubtful if a curve of this kind could be

*Westinghouse Electric Company.

even estimated. I do not believe that the average coal operator realizes the large increase in upkeep caused by poor voltage regulation.

Mr. Adams gives a formula for figuring the circular mills required for feeder circuits for underground transmission. In this formula the rail return is probably figured to be equivalent to the overhead copper. I believe that the rail return should be first estimated and then the remaining drop in voltage applied to the overhead copper. A very simple way of estimating the rail return is to remember that each square inch of rail will weigh ten pounds per yard. If we have two 50-pound rails the weight will be 100 pounds per yard and the area 10 square inches; the area of 10 square inches in circular mills is about 12,500,000. Where rails are fairly well bonded and properly cross-bonded the equivalent section of copper is about 12 to 1. The equivalent section of copper, therefore, for two 50-pound rails is about 1,000,000 circular mills.

Mr. Adams states that a great many mines start out with a No. 40 trolley and only add copper after the motors refuse to operate. This is not only true in a great many instances, but in many cases the addition is all made to the overhead system and the rail return is neglected. Particular care should be taken that the rail return is not only kept in good condition, but supplemented by copper feeders where necessary.

Mr. Adams also points out that the conditions in one mine are different from other mines, so that a set of hard and fast rules can not be laid down to suit all coal mines. The layout of a power system for the coal mines in Illinois may be far different from that of a mine of the same capacity in West Virginia.

I heartily agree with Mr. Adams in his recommendation for values of voltage for cutting and locomotive circuits. Mr. Adams mentioned certain qualifications which should be obtained in the modern mine substation. I believe that we can go a few steps farther and recommend the installation of automatic sub-stations for a great many coal mines. The advent of the automatic sub-station will greatly assist in obtaining good voltage regulation since this can be obtained much more economically than with a manually operated station. The automatic sub-station will do all that can be done by the manually operated stations much more promptly and makes no false moves. The automatic sub-station has proven its value in railway work, and the first station has been operating for some months in one of the mines of Pennsylvania. A number of other automatic sub-stations will be installed in the near future in some of the mines of southern Illinois. I feel that a great many of the recommendations of Mr. Adams can be very economically met by the use of the automatic sub-station.

C. W. Place*—Figure No. 3 of this very interesting paper has impressed me very forcibly as illustrating the absolute necessity of maintaining a reasonable voltage throughout a coal mine. A machine worked mine operates on a particular day, and during this day it is desired to get out the maximum amount of coal at the least expense. The key to the whole situation—if you consider the soldiering of labor as a fixed quantity—is the maintenance of voltage where the work is being performed. It is evident from figure No. 3 of this paper that if 160 volts are always available, local conditions and the peculiarities of the work do not have a great influence on the time for the particular work, but below this voltage it may take anywhere from 5 to 20 minutes to do the same amount of work. Above this critical voltage there is a gradual improvement with better voltages.

The time for doing a particular job means the production for a given investment in equipment. Energy consumed for the particular job is of relatively less importance, but the watthour curve in this figure emphasizes the value of maintain-

*General Electric Company.

ing voltage at the work as affecting the power bill. Since both the time and the energy consumed increase so quickly, it seems absolutely necessary that the operating voltage always be above this critical point, and that therefore in a large mine considerable expense is warranted in accomplishing this. The use of automatically controlled machines near the work seems to be the only way that this can be positively and economically accomplished. The use of such control for machines in other fields has proven that it is more reliable than hand operation ,and that it is economical to take all the precautions possible to maintain this reliability.

Figure No. 3, to my mind, proves definitely that the coal mining industry can not afford to take chances on the score of reliability of their voltage supply since this is a key to the economical production of coal.

G. E. MARBLE—In connection with the use of converter equipment underground, the author makes the statement that it is usually possible to increase the voltage at the load centers (i. e., at the partings) 5 or 10 per cent and justify the additional cost. I believe he is perhaps a little too conservative in his statement.

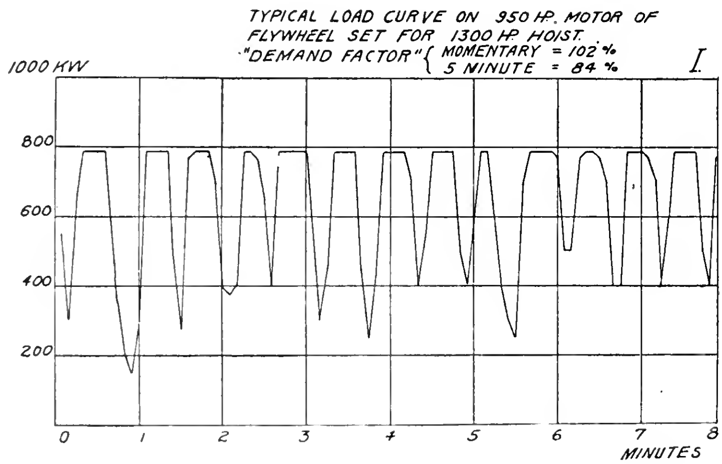
Let us assume, for example, a large representative mine, worked in four directions from the shaft, and with ten active partings, four or five m. g. sets would probably be required for this mine. Each set would take care of at least two partings. The set would be located probably at one parting and feed through to the other partings. The voltage at the first parting would be 275 at full load, and at the other, assuming a distance of 2,000 feet, 800 amperes maximum, sustained demand, and 500,000 c. m. feeder cable, we would get 270 volts.

The curve in figure 4 allows 199 volts at the partings for this number of amperes. If, then, we are able to get so good a voltage at the partings, we ought to get a good voltage at the face, providing we observe the further suggestion in Mr. Adams' paper, namely, of permitting a drop of only 10 volts between the partings and the working face.

Demand Factor of Coal Mining Loads

Presented by CARL LEE,* April 25, 1921.

The determination of the size of power plant, capacity of generators, cables to mine bottom and sections of the mine is often made without due consideration of the controlling factors. The two principal terms used in calculations of the above are "Load Factor" and "Demand Factor." In order that the two be not confused the definitions are here given:



"Demand Factor"—"The ratio of the maximum demand of any system or a part of a system, to the total connected load of the system, or of the part of system under consideration.

"Load Factor"—"The ratio of the average power to the maximum power during a certain period of time."

The two are very closely related and if the "Load Factor" of a single motor is known it is much easier to estimate the "Demand Factor" for a large group of motors.

APPLICATIONS OF ELECTRIC POWER

The principal applications of electric power to bituminous coal mines are as follows:

1. Mine ventilating fans.
2. Electric hoists.
3. Crushers and washers.
4. Shop and tipple machinery.
5. Pumps and booster fans.
6. Mining machines.
7. Locomotives.

The above will be considered in the order named.

MINE FANS

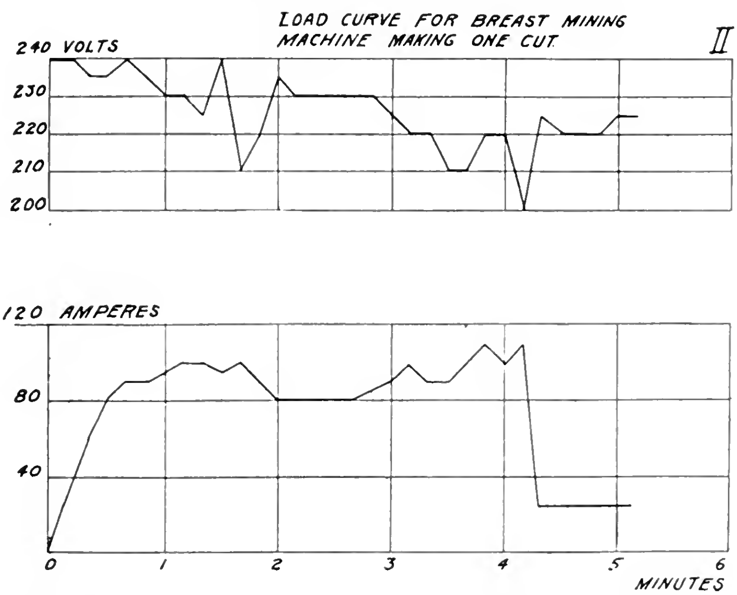
The mechanical efficiency of modern fans varies from 45 per cent to 65 per cent from pulley to air delivered. The volume of air depends on tonnage of the

*Electrical Engineer Peabody Coal Company, 332 So. Michigan Ave., Chicago.

mine and number of splits. The pressure depends on the length of airways, their size and condition and also number of splits. Knowing the volume and pressure necessary and the efficiency of the fan it is easy to determine the size of the motor necessary. In order to allow for extension of the mine it is always well to have the motor somewhat oversize at the time of installation, then as the mine develops it is possible to speed up the fan, thus requiring more horsepower. The "Load Factor" of a fan is usually unity and the "Demand Factor" is somewhere between 60 per cent and 110 per cent, depending on allowance for expansion of the mine

ELECTRIC HOISTS

Electric hoists are special in their application and each case should be estimated by competent engineers. In a well designed hoist of the Ilgner type the five minute "Demand Factor" is approximately unity since the motor driving the fly wheel set



is just fully loaded when operating at the rated capacity of the hoist. The momentary "Demand Factor" is of course higher. On Plate "I" is shown a load curve on a 950 H. P. motor of a flywheel set driving a 1,300 H. P. D. C. hoist. Here the momentary "Demand Factor" is 102%, and the five minute "Demand Factor" is 84%. This indicates that the output of the hoist could be increased by decreasing the caging time or increasing the speed of the hoist, or both. The average efficiency of four Ilgner hoists of 675 to 1,300 H. P. in operation for several years is 45% to 48%. Thus the K. W. H. input and "Demand Factor" for a properly designed hoist can be easily predetermined.

CRUSHERS AND WASHERS

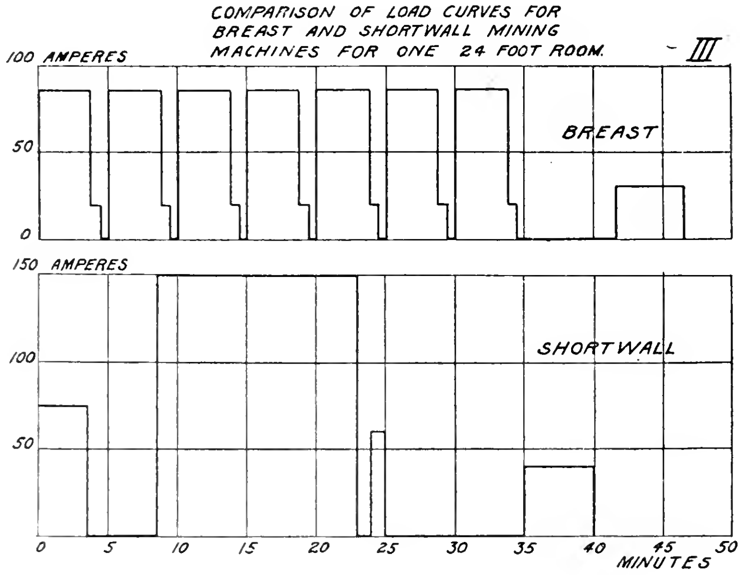
This is more or less special application but the same general remarks would hold as for the next class.

SHOP AND TIPPLE MACHINERY

The selection of motors to drive ordinary tipple machinery is very generally understood and the "Demand Factor" will usually run high as there are many times when the rate of output of coal reaches a point where every piece of equipment is loaded. In such a case the motors are well loaded, possibly reaching 90% "Demand Factor" for all combined. The total load rarely exceeds 150 H. P., so it is not a serious electrical problem in the average mine.

PUMP AND BOOSTER FANS

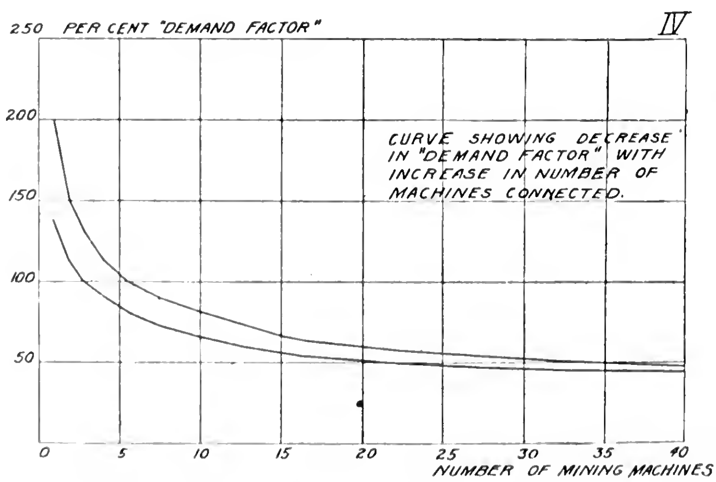
Pump motors are usually very liberally selected. This is done to allow for different load conditions that may be encountered either at original location, or some other location to which motor may be moved.



Pump loads are not ordinarily a serious consideration in coal mines in this field. In one mine with 14 motors totalling 225 H. P. connected to pumps the "Demand Factor" is 44.5%. Another with seven motors totalling 65 H. P. connected to pumps the "Demand Factor" is 54%.

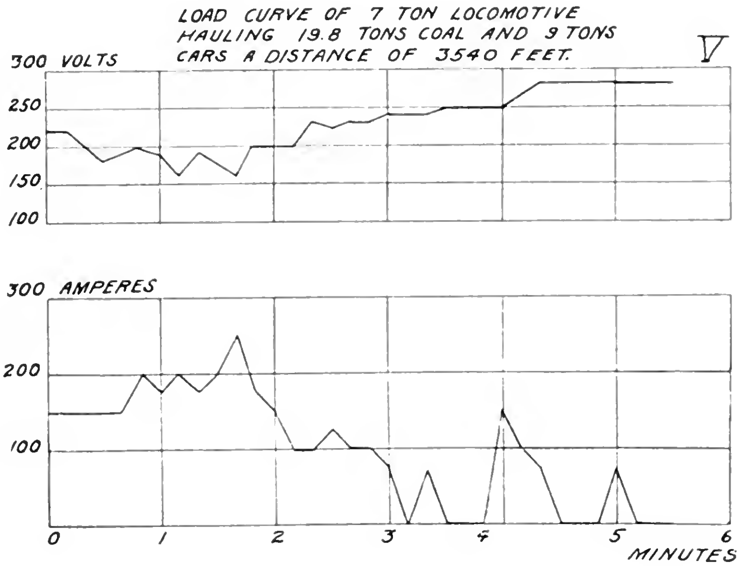
MINING MACHINES

The manufacturers of mining machines have learned through years of experience what size motor should be installed in a certain type of machine. The motors are rated on a one hour basis since the work is intermittent.



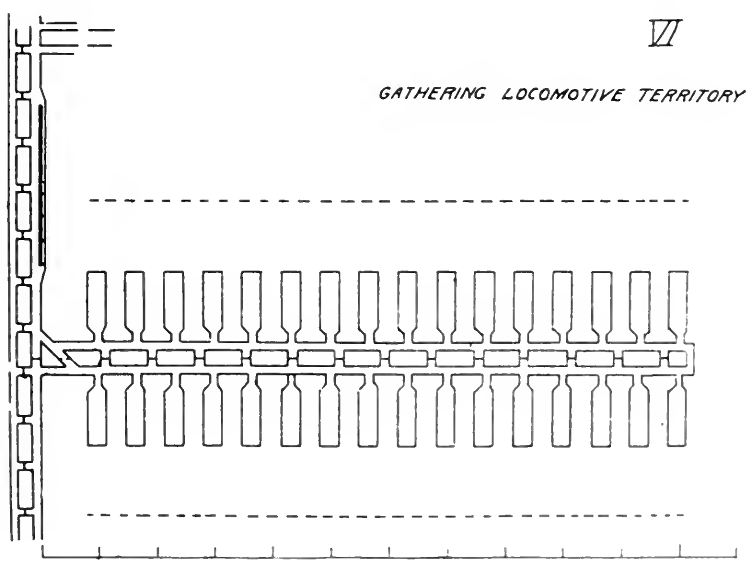
The average sizes of motors now installed on mining machines are from 22 to 25 H. P. for breast machines, and 30 to 50 H. P. for short-wall machines. In extremely hard cutting a single machine of either type may reach a five minute "Demand Factor" of 150%. In easy cutting the same machine might not exceed 75% of its rating.

An actual test on a breast mining machine for one cut is shown on Plate II. The operation of a breast machine is such that continuous load on the motor will not



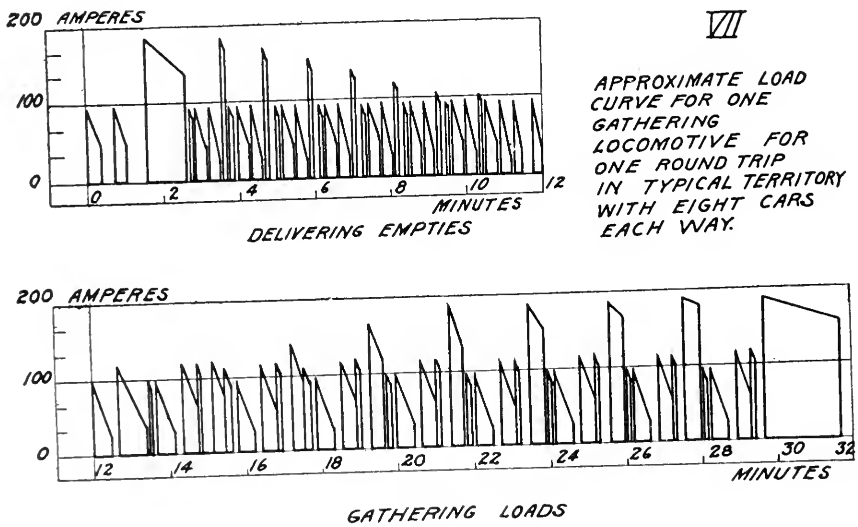
ordinarily exceed five minutes. The short-wall machine is designed to cut across a short face such as the face of a room 18 to 35 feet wide or an entry 9 to 18 feet wide, at the rate of 12 to 24 inches per minute.

Plate III shows a comparison of characteristic loads of the two types of machines. The curves are not actual but represent the average results of a number of tests on machines. The presence of various forms of impurities known to the miner as sulphur balls, black jack, slate or clay increase the load on the mining machine. This is a natural condition which is usually unavoidable. Worn gears,



cutter heads, guides and chains increase the load. The remedy is obvious. Lack of oil and dull cutter bits, also increase the load rapidly. These are under the direct control of the machine runner. In some cases a set of bits may last a day and in worse conditions six to twelve sets may be required per day. The number of bits used indicates the hardness of cutting and may be used as a guide in estimating the "Demand Factor" of a single machine.

By taking the curve for the short-wall machine and superimposing it a number of times on itself so as to secure the lowest peaks the lower curve shown on Plate IV is derived. Next assuming a momentary "Demand Factor" of 200% load for one machine and the maximum continuous capacity, or about 50% of the one hour



VII

APPROXIMATE LOAD CURVE FOR ONE GATHERING LOCOMOTIVE FOR ONE ROUND TRIP IN TYPICAL TERRITORY WITH EIGHT CARS EACH WAY.

capacity, of a total of 30 machines, the upper curve is obtained. It is evident that for the assumed conditions the average actually obtained lies between the two curves. For easier cutting or less regular work done than that assumed for the curve on Plate III, both the curves are lower.

Thus it appears that for a large number of machines the "Demand Factor" for the group approaches but never reaches, the "Load Factor" of a single machine over the same period.

Therefore it is necessary to know how much each individual machine works each day before the "Demand Factor" for a group can be estimated.

LOCOMOTIVES

The highest "Demand Factor" of a locomotive properly operated is usually predetermined by the manufacturers. The common practice is to equip the locomotive with 10 H. P. per ton weight. The one hour current rating is about 90% of that required to slip the wheels, thus the "Demand Factor" for a single locomotive is 110%. The eight hour rating is only 45 to 55% of the one hour rating, so that the "Load Factor" does not exceed 40 to 50%.

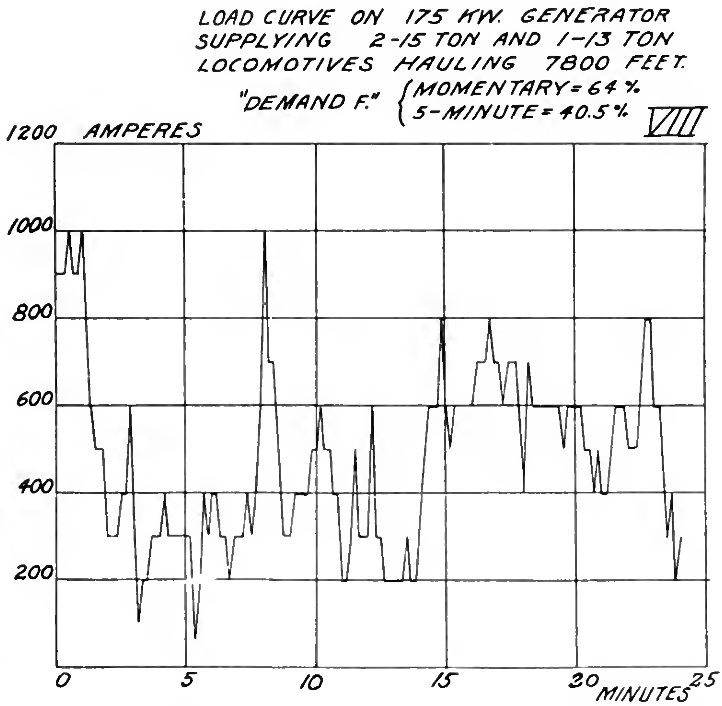
The characteristics of coal mine service of locomotives is extremely variable. There are a number of factors that enter into consideration, the principal ones being:

Length of haul
Ruling grades
Short grades
Condition of track and cars
Voltage regulation on trolley
System of haulage
Required output
Concentration of coal

A test on a haulage locomotive is shown on Plate V. The "Load Factor" for the run is 38%. The return trip with the empties requires about three-fourths

the time and two-fifths the power so that including the time waiting on the parting and on the bottom the "Load Factor" does not exceed 25% for one round trip. This, however, is too low for some installations where the run is longer and where the grades are very small, in which case large trips are hauled giving a steady load.

Gathering locomotives have about the same momentary "Demand Factor" as haulage locomotives, but they have in exceptional cases only as high a five minute



"Demand Factor." On Plate VI is shown a model pair of entries with rooms being worked on both entries. The coal from this territory would be gathered with one locomotive.

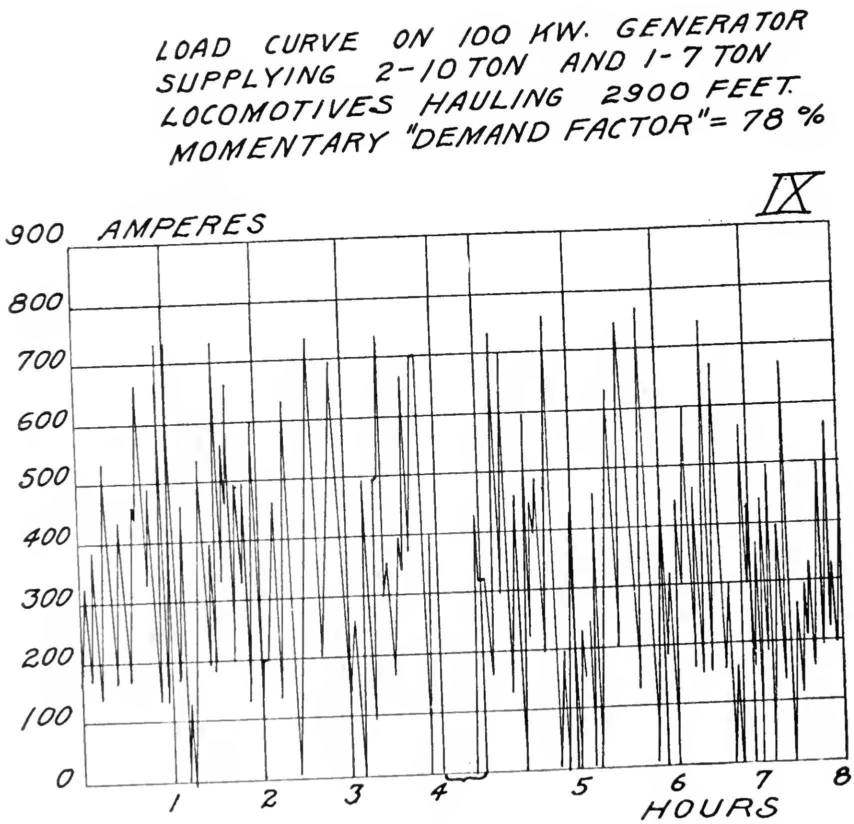
The curve on Plate VII is based on actual time tests of a gathering locomotive and current estimated from characteristic curves, when locomotive is operating in territory similar to that shown on Plate VI.

The "Load Factor" for a single gathering locomotive is lower than for a haulage locomotive, and the "Demand Factor" is the same for both so that the "Demand Factor" for a large group of gathering locomotives is lower than for the same number of haulage locomotives.

Plate VIII shows readings taken every 10 seconds on a 175 K. W. Generator having 2-15 ton and 1-13 ton locomotives hauling an average distance of 7,800 feet. The "Load Factor" for 24½ minutes is 48% and probably would be 40% for 8 hours. The momentary "Demand Factor" here is 64% and the 5 minute "Demand Factor" is 40.5%.

Plate IX shows readings taken at 2 minute intervals on a 100 K. W. Generator for 8 hours during which 2-10 ton and 1-7 ton locomotives totalling 270 H. P. hauled 1,979 tons an average distance of 2,900 feet. The last four classes of equipment considered above are the most commonly encountered and are most important to the average coal mine operator. Actual tests of maximum demand on D. C. Generators over long periods are rarely made. Power house attendants can keep a record of the number of times that the circuit breaker is out, and an engineer knowing that and the setting of the breaker can obtain a general idea as to adequacy of generators.

Plate X shows the sizes of generators and horse-power connected loads of 26 coal mines. From this data the upper and lower lines may be taken as maximum and minimum sizes of generators that should be installed. The middle line is an average that could be generally used. This shows a "Demand Factor" of 83% for small loads and 47% for the highest load included, assuming 50% overload



capacity of generators. With the increase in totally electrified coal mines nearly all of the principal applications named are to be considered.

Plates XI, XII and XIII show the five minute load curves for one working day of each of three totally electrified mines. The one on Plate XI is a fully developed mine using trolley-reel gathering locomotives; the one on Plate XII is also a fully developed duplicate mine of the first except that storage battery gathering locomotives are used; and Plate XIII shows the load on a new mine which when developed will be similar in nearly all details to the second described. The present tonnage is about 50% of that expected later.

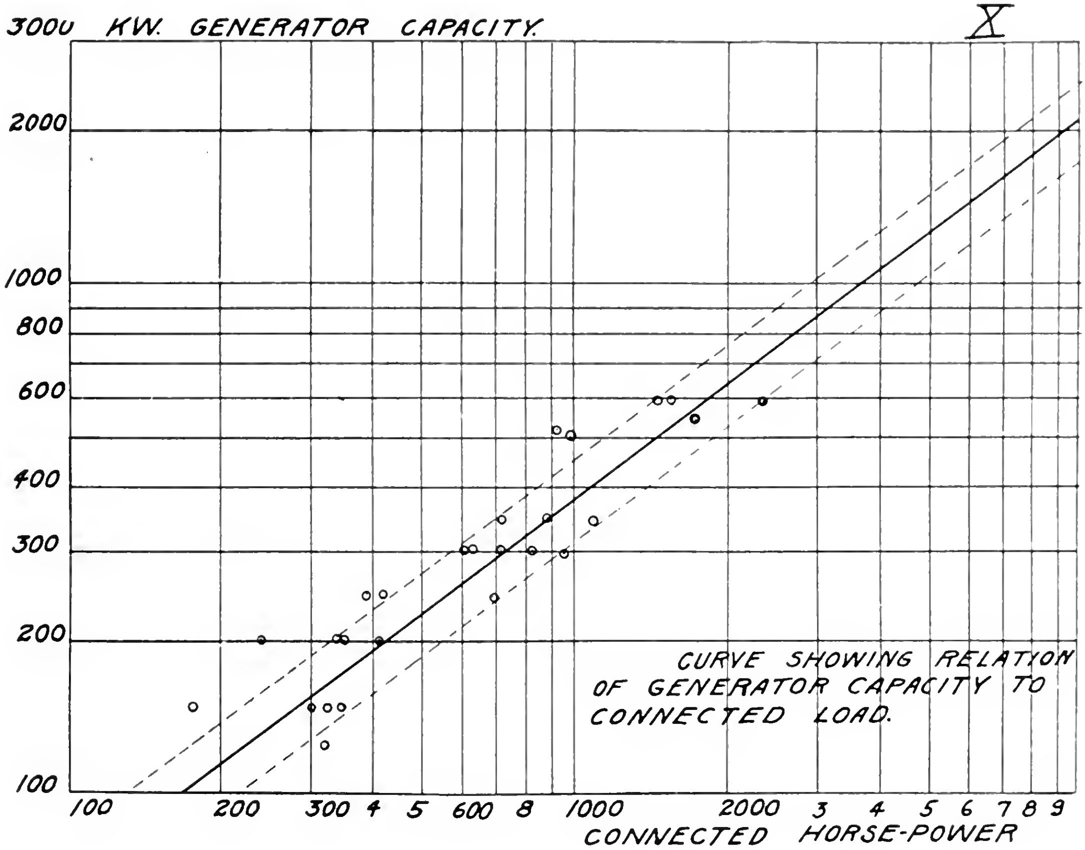
The "Demand Factors" on these mines is higher than for inside equipment alone, because the top equipment includes the hoist and fan motors which are continuous rated motors and which have a high "Load Factor."

DISCUSSION

GRAHAM BRIGHT*—Mr. Lee in his very valuable paper has brought out very strongly the importance of the "Demand Factor" in determining the capacity of generating equipment for coal mines. I believe, however, that he should lay a little more stress on the time element involved when using the expression "Demand Factor." Curve 1 shows a typical load curve on the A. C. motor of a flywheel hoist equipment. The momentary demand factor is 102% and the five minute demand factor 84%. It would be interesting to see this same curve drawn up for an alter-

*Westinghouse Electric Co.

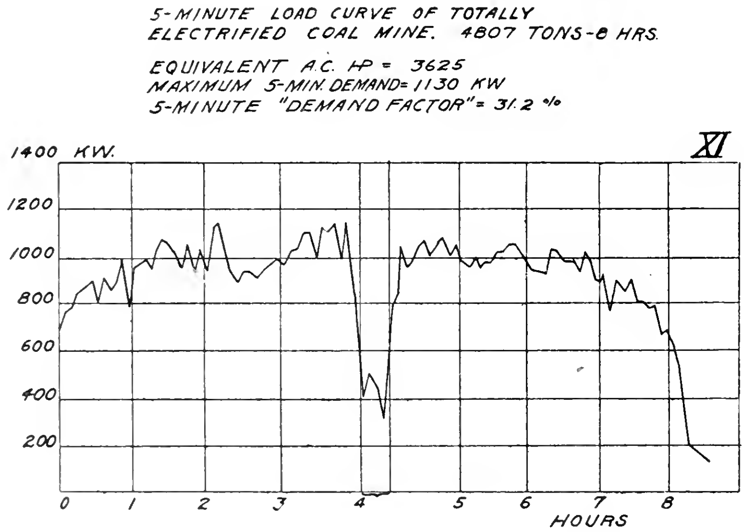
nating current hoist motor of about the same capacity. It would probably be found that the five minute demand factor would be about the same as with the flywheel set, but the momentary demand factor would probably be over 200%. For this



reason it is very important that the momentary value be given as well as the factor based on five minutes or any other interval of time.

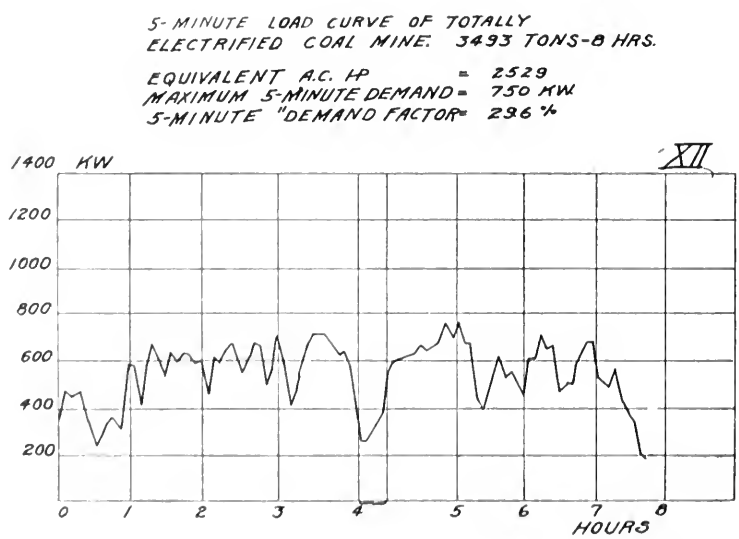
As Mr. Lee states under "Electric Hoists" the curve shown on Figure 1 indicates that the capacity of the hoist might be increased by decreasing the caging time or increasing the speed of the hoist or both. This is probably true as regards the A. C. motor, but care should be taken that the D. C. generator and the D. C. hoist motor have as much margin as is shown for the A. C. induction motor. It is possible that the D. C. machines are already loaded from a heating standpoint and could not safely stand any increase. Curve 4 is of particular interest to the writer as it bears out his method of estimating the capacity of the generating equipment to supply power for locomotives and cutting machines. Where a single machine is involved it will be noted that the demand factor requires momentary loads up to 200%. It would be necessary to supply a direct current generator of 100% capacity since the momentary overloads should not exceed 100%. The 100% capacity of a mining machine or locomotive is, however, based on the hour rating and the continuous rating will be from 45 to 50% of this value. For a single mining machine or locomotive, therefore, it is generally necessary to install a generator twice as large as necessary from a heating standpoint, in order to take care of the momentary peak loads. Where a fairly large number of machines are involved, however, the diversity factor comes in until it is only necessary to supply generating capacity equivalent to the continuous rating of the machines after about twenty or more machines are involved.

Motor generator sets and rotary converters are built to stand momentary overloads of 100%. This should also be the case of engine driven generators, but in many cases generators of this type are not able to supply more than 50% overload, due to the restricted capacity of the prime mover. Where alternating current gen-



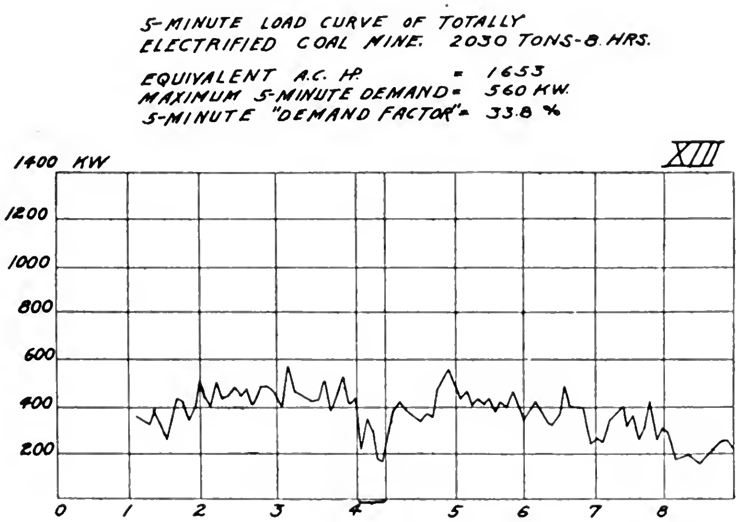
erators are involved it is the standard practice today to install the overloads expected of D. C. machines so that allowance must be made in their installation to take care of overloads.

Curves 11, 12 and 13 of Mr. Lee's paper indicate in a general way that for the mines of Illinois a maximum five minute demand from the power plant is approximately one-fourth of the capacity of the mine in tons per eight-hour day. This, of course, is a very rough figure but gives a general indication of the capacity required in the power plant.



I feel that Mr. Lee's paper should be followed by another to be presented at some meeting in the near future in which he will work out an example assuming a mine to be opened up to a certain capacity, in which he determines the actual capacity of the generating equipment and the feed lines running to the various parts of the mine.

K. A. Pauley—Mr. Lee has given some very valuable operating data with reference to the application of electric power to coal mining, and the Institute is to be congratulated for this contribution from one so well qualified to speak with



authority. This paper and the curves which accompany it will surely be of very great value to those contemplating the electrification of new mines or the conversion of the steam equipment of old mines to motors.

It is interesting to note in connection with this paper, althought it does not have a direct bearing on the material which Mr. Lee has presented, that in spite of the fact that fuel is extremely cheap, coal mines have electrified to a greater extent than metal mines where fuel is much more expensive and conditions at first thought appear much more favorable to electrification.

It is of further interest to note that most of the coal mining companies purchase their power which is very conclusive evidence of the advantages of electric drive over any other and of the fact that it is to the interest of the mining company to purchase power and invest the capital necessary to install his own generating plant to further extend the mining operations.

A careful analysis of the curves of Mr. Lee's paper should show the mining engineer that public utilities can sell power at a profit at a price equal to or better than it can actually be produced by a mining company operating a small isolated plant although it may be possible to show on paper that the mining company can do at least equally well.

The Michigan Boulevard Improvement

Abstract of an address by Hugh E. Young* before the Society, April 12, 1920, dealing particularly with the engineering features of the Boulevard Link Bridge.

GENERAL.

The Michigan Avenue improvement extends from the north line of Randolph Street to the south line of Chicago Avenue. The part of the improvement on the north side of the river between Ohio Street and Chicago Avenue is a street improvement. The width of the street is 104 feet. The roadway is 80 feet wide. The parkways and the walks on either side of the roadway occupy a space of about thirty feet.

The pavement for this improvement, the asphalt pavement, has a concrete base. One interesting feature of this particular part of the work was the placing of all the public utilities underground in the parkways between the curb lines and the building lines to avoid digging up the street after the pavement is laid. The upper level between the north line of Randolph Street and Ohio Street is a boulevard, being 141 feet wide on the north side of the river, having an 80 foot roadway and 30 foot walks on either side of the roadway.

On the south side of the river the street is 127 feet wide, having a 75 foot roadway and walks 25 and 27½ feet wide. The lower level of the improvement extends from Lake Street to Grand Avenue and is paved with granite block pavement the entire width of the street. Along the building frontages between these limits are constructed loading platforms to facilitate the handling of freight. All of the east and west streets such as Grand Avenue, Illinois Street, Austin, North Water, South Water and Lake Street, pass under the upper level of this improvement and connect with the lower level of Michigan Avenue. It was necessary in some cases to depress the streets as at Grand Avenue, Illinois Street and make a slight depression at Austin Street. At North Water Street it was necessary to raise the street slightly. All utilities between these limits are placed on the lower level. Stairways are provided at street intersections to give ready access from the lower to the upper level. The only ducts or cables that are placed in the upper level are those for street lighting purposes. The foundations for the north approach and the south approach are similar. The fill approaches between Randolph Street and between Ohio Street and Grand Avenue and on the south approach between Randolph Street and Lake Street have the retaining walls along the curb lines. These retaining walls are supported on pile foundations. The space between the building lines and these retaining walls is used for sub-sidewalk purposes, and in these sub-sidewalk areas are placed the utilities, so that a very strenuous effort has been made to place all the underground utilities in this entire area either in sub-sidewalk areas, in the lower level, and in the parkways on the North Side.

The foundations for the superstructure generally consist of pile foundations capped with concrete. In some places where the columns were located near or over tunnels concrete caissons were used, and in other cases the caissons were combined with the pile foundations to give cantilever foundations, which were brought about by having beams projecting or cantilevering over the caissons and tied back on the pile foundations. In other words, where this type of foundation could not be used, two caissons were used straddling the tunnel, on which was placed a concrete beam which in turn supported the columns for the superstructure. The superstructure of the approaches north and south of the river are similar. Over the sub-

*Engineer Chicago City Plan Commission.

sidewalk areas are placed I-beams about four to five foot centers, which are encased, the upper parts of them, in a four-inch slab. One end of these beams is supported on the retaining walls along the curbs and the other end is supported on girders parallel with the street, which, in turn, are supported on foundations about eight feet six inches out from the building line. The ends of these beams cantilever this distance of eight feet six inches from the row of girders near the building lines and is a very efficient way of constructing the sidewalks along the improvements for the reason that they readily adapt themselves to the varying locations of buildings. On every improvement, some buildings are out one foot, two feet, three feet, or maybe more, or they may be back that much. It is just a matter of cutting off the ends of these beams and building the sidewalk up to the building line, with a provision for an extension.

The superstructure for a viaduct part is of the usual steel column girder floor beam construction. There are two rows of columns about eight feet six inches out from the building lines; another row along each curb, and a row of columns along the center line of the street. The columns are spaced about 28 feet in the direction of the street and support the framework of floor beams which in turn carry the stringers. Intermediate floor beams are also provided which in turn are connected to the floor beams that run in a longitudinal direction of the street so as to give a span of about 14 feet for the stringers. As on the sub-sidewalk areas over on the fill approach, the sidewalk beams on the elevated structure are arranged with the slabs extending in the transverse direction of the street, supported in a similar manner as those on the filled approach. The roadway slab is about eight inches thick and is re-inforced with half inch bars so arranged that they are six inch centers over supports and at center beams. The sidewalk slab is four inches thick re-inforced with mesh.

In constructing the foundations for the plazas the contractor first drove the piles. Then he started the construction of the deadmen, then drove the piles for the docks. The piles and sheeting of the docks are capped with large blocks of concrete. The elevation of the top is about 5 feet plus.

After the piles for the dock were driven and the rods were placed anchoring these docks to the dead line, the areas between the dock and the shore were then filled—in these particular places with clay and cinders. They were figured to withstand a pressure due to clay, but later it was decided to use some cinders in order to relieve this pressure, as it was considered a little more conservative.

FOUNDATIONS.

The foundations for the bridge proper consist of two large concrete re-enforced counter-weight pits, one on each side of the river. The counter-weight pits are much like a large concrete box having four sides and a bottom. These pits are supported on concrete bases which are carried down to rock, or hardpan, depending on the conditions determined in the field. Allowable pressure, as a rule, for caissons on hardpan varies from six to eight tons; and in these cases it was necessary to bell out the caissons in order to get the desired unit pressure. Where the caissons are carried to rock unit pressures of 350 pounds per square inch, which I think amounts to about 25 tons per square foot—varying from that to 30 tons per square foot—were used. The caissons under the outer trusses of the river pier were nine feet in diameter and at the center of the bridge under the river pier I think they are 12 feet in diameter. The caissons under the trunnions on the outer trusses are 10 feet in diameter and those at the center are 12 feet in diameter. The caissons under the anchor pier on the pits on the outside are 7 feet in diameter and those at the center about 7½ feet in diameter. The abutments back of the pits are supported

on timber piles. The cross girders that support the trunnions of the bridge are supported on grillage beams imbedded in the side walls of the pit, and at the center of the bridge are supported on steel columns which extend down and bear on caissons. The machinery for operating the bridge, the frame of the machinery gear trains which operate the bridge are supported on grillage beams imbedded in the concrete in the side walls of the pit. The live load reactions of the truss is carried on grillage beams under these trusses on the river pier, both at the outsides and at the centers. The anchorage for taking the uplift due to the live load acting with the river pier is taken by beams of steel columns imbedded in the anchor pier of the pits. The bottoms of these anchorages are placed as a rule at the top of the floor of the counter-weight pit in order to facilitate the adjustment of these columns, it being necessary to pour the floor first and provide grout here, and it is very necessary that they be placed at the correct elevation in order to assure that the stringer work when placed will fit and be at the correct elevation.

The large steel column that supports the cross girders at the center of the bridge are encased and stiffened by means of concrete walls extending back to the river pier. The concrete for this wall, however, was not placed until after most of the loads had been placed on the columns, in order to avoid cracks owing to what settlement might take place. The upper part of the river piers are about six feet thick, the lower part seven feet nine inches. The river piers are about five feet thick at the top and seven feet six at the bottom. The side-walls of the pit are four feet six except the lower portions which have extensions on which are fastened the emergency brake track castings. The floor of the pit is about five feet thick, varying somewhat, due to the fact that the floor is sloped to provide drainage to sumps which are connected with the pumps for pumping out the pits. The vertical loads used in designing the pits are for the floor—two cases—downward pressure consisting of the weight of the masonry taken as 150 pounds per square foot, and that due to water pressure in the pit, it being assumed that the pit has about 12 feet of water in it. In this case it would happen when the pit is enclosed in a coffer-dam.

For upper pressures the factors that should be considered are those due to buoyancy and hydrostatic pressure and the weight of the masonry itself at 150 pounds per cubic foot, and the pit empty. The vertical loads on the river pier, the anchor pier and side walls are the dead loads of the superstructure, three-quarters of the live load of the super-structure, masonry taken as 150 pounds above datum and 50 pounds below datum. For the horizontal loads on the side walls and the anchor pier earth pressure is taken above datum as about 28 pounds per square foot, and below datum 60 pounds per square foot for one case, the other case being half of the water pressure from the inside, which might be the case where the pit is full of water, and it being enclosed in a coffer-dam. The river pier is figured for internal and external loads of water pressure up to datum.

The floor is figured as a slab supported by the four walls of the pit and has been re-inforced laterally and longitudinally; the floor has been figured as a slab supported by the walls of the pit and consequently, over a girder at the center of the pit. The re-inforcing steel was distributed, for the transverse or longitudinal directions, inversely as the fourth power of the span. The span for the short span being about 33 feet and the long span about 49 feet.

The river pier, anchor pier and the side walls have been figured for vertical loads as continuous beams over three-fourths and for the lateral loads or horizontal loads the side walls have been figured as beams supported by the floor of the pit and horizontal girders at the top of the pit which extend from the river pier to the anchor pier. The horizontal girders are re-inforced on the lower side for the ver-

tiacl loads of the enclosure walls and superstructure, and the inner sides for the horizontal pressure caused by the pressure on the side walls.

The anchor piers have been re-inforced for horizontal pressures due to earth pressure on the outside, and the water pressure on the inside, and is figured as a retaining wall supported by the side walls of the pit and the buttress formed by the extension at the center of the pit, which is also used as a support for the emergency brake rail casting (or casing). The river pier is figured as a retaining wall with proper allowance made for the resistance given by the side walls, and in the design of the pit floor provision is made for the moment induced by the cantilever action of the river pier about this connection with the pit floor.

Coffer-dams for the pits are so constructed that provision is made for a clearance of about two feet from the inner edge of the dam to the network of the concrete pit, so that there will be some allowance for the caving in, so to speak, of the inner row of the sheeting. The dam is built, or consists, of a row of sheet steel which encloses the entire counter-weight pit and then an outer row of timber piles and sheeting spaced about 10 to 12 feet from the inner row of sheet steel. The space between the sheeting is filled with clay or any other suitable material, in order to give it a proper puddle. The puddle walls are braced by means of 12x12 timbers spaced about 10 feet centers, and in layers, about 5 foot centers, in the depth of the pit. Within the area of the coffer-dam itself are driven at certain places timber piles to support the bracing and take the sag that would naturally come by having such a large area of timber or bracing. When the bracing has been carried down to the necessary depth, the bottom 5 foot spaces cleared of all bracing, and piles, with the exception of those that support the center part to take the sag here and around these piles, on the bottom are built conical shaped forms, and after the concrete floor has been poured, and of course the walls are carried up and the pit finished, these piles are cut off below the bottom of the pit and then these openings are plugged with very rich concrete. This method has been used on a number of city bridges with success.

The concrete for the counter-weight pits, the mix was 1—3—5, to which was added hydrated lime, about 8 or 9 or 10 per cent, or about one quart to each bag of cement. Hydrated lime has been used with success, not alone on the pits for the Michigan Avenue bridge, but also the Franklin-Orleans bridge and others. It certainly does facilitate the pouring of concrete. It makes a much denser concrete, too. You would have no leakage of these pits except that due to minor cracks which quickly fill in. These cracks were perhaps hair cracks.

BRIDGE STRUCTURE.

The Michigan Avenue bridge is known as the double deck double leaf trunnion bascule bridge. Each leaf has four trusses. The center of the outer trusses is about sixty feet center to center. The center to center of the inward trusses is about 6 feet. Each leaf is split longitudinally to center, making the centers of the two trusses for each half 27 feet center to center. The trusses do not project above the upper level but in order to obtain an improvement in the appearance of the bridge the bottom chord was raised at the center above the lower floor approximating the curve of a parabola. This made it necessary, of course, to suspend the portion of the roadway from about the second panel point on. The appearance of the bridge has been greatly improved by having the gusset plates curved, and this was done in the shops by means of the oxy-acetylene torch.

On the upper level or upper deck is placed an ornamental iron hand railing with structural rails and supports and with panels made of cast iron. The lower level railing is of simpler design and it is constructed throughout with wrought iron and malleable casting. The abutments for the bridge are very wide and are con-

structed from the level of the dock to the lower level street of granite, backed with brick, and from the lower level to the upper level they are constructed of Bedford stone. The specifications called for buff Bedford. The houses are also faced with Bedford stone. The stone work for the ballustrades and ornamentation around windows and belting and cornices will be very richly carved and give a very pleasing and ornate appearance to the bridge.

The distance between center to center trunnions of the bridge is 256 feet. The distance between masonry is 220 feet. The government requires a clearance of 80 per cent of the distance between masonry, which in this case amounts to 176 feet. The city ordinance requires that when the bridge is raised no part of the structural steel shall extend beyond the river coping for at least 170 feet above datum.

Each length of the bridge is figured as a cantilever with the reaction at the trunnion for dead loads, and for live loads it is figured as a cantilever with the reaction at the river pier, and at the anchor columns, and the extraordinary case of where it is assumed that the live load acting about the river pier lifts the load at the trunnion. The depth of trusses at the center is 11 feet, at the river pier about 27 feet. The panels are spaced about 14 feet center to center. The factors that determine the location of the trunnion are many and they vary in every bridge. It is very hard to lay down any hard and fast rules. Some of the factors that govern the location are the grades. In this particular bridge there is a grade on the upper level, the grade on the lower level under which must be placed the trunnions, the distance that the paneling extends back of the trunnions in order to keep the material down within limits of sheet material, all of which conditions will control the location of the bottom chord from the river pier to the connection with the counterweight box.

Another condition that we considered is the depth of truss at the rear part. Another condition is the bridge and floor on the upper deck, as this floor revolves back it must not foul the floor back of the breaking floor. These factors caused the trunnion to be located about 14 feet back of the center line of the river pier.

The outline of the bottom chord must satisfy the condition of 16½ feet clearance above datum for the government requirements, after which the outline followed that of giving the best appearance to the structure.

As stated, each leaf of the bridge is split longitudinally into two parts. It was therefore necessary to provide for bracing between the inner trusses in order to carry over deflections that would be caused by the live load on one leaf, and in order to do that heavy diaphragms were constructed at each panel point, the head of the trunnion, and at the back of the trunnion members wherever clearances would permit. Without going into a long theoretical analysis of what would be put in there, we simply put the diaphragms in there sufficiently to take the live load from one truss and back of the points provided diaphragms there that would take the entire shear load that might come on one pinion. The upper level of the roadway is 27 feet between curbs. In fact, the sidewalks are 15 feet wide, floor beams spaced about 14 feet and the stringers about 2 feet 10 inches. The flooring will be 6x12 sub-blocking, calked in, on which will be placed a rectangular block supported at intervals of six feet with small angles. Knee bracing was provided at each floor beam in order to improve the looks of the upper level, that is, the under-side of the floor from the lower deck, also to stiffen up the structure transversely.

The lower level of the bridge has two roadways 18 feet curb to curb and two walks about six feet wide. The roadway planking on the lower level will consist of 6x12 sub-planking laid close, on which will be placed rectangular creosoted block. The part of the grade on the upper and lower level roadways are about one-half of one per cent, except that on the lower roadway from a short distance ahead of the

river pier there is a break in grade and from that point back on the approach there will be a three per cent grade, and for this part of the lower level pavement sandstone block will be used, which will be better for traffic than creosoted block, as a sandstone block has probably the least factor of slipperyness of any pavement, except something that will give a corduroy effect like having spacers placed between the creosoted block, which has been used more or less successfully on some of our city bridges. The sidewalks on the upper level are tied back to the trusses by means of angles, in order to take the sag when the leaves are raised. Both on the upper and lower levels for the two end panels the lateral bracing has been fastened by means of three-quarter inch bolts temporarily so that adjustment would be possible. I might say that these end panels or bracing are to be drilled and reamed in the field, except that in each connection one or two holes were provided in the shops, in which were placed three-quarter inch bolts so that when the bridge is lowered, should it be out of line the trusses could be pulled over by means of steamboat jacks. This actually happened at Michigan Avenue and the bridge was readily pulled over in this manner.

The trunnions of the bridge are supported by means of cross girders which extend from the side walls of the pit to columns located at the center of the pit. These cross girders are box section and have been provided at points where the trunnion bearings come with shims of varying depths to take the deflections that come on the bridge when the bridge is fully loaded. The deflection must be anticipated and proper shims provided. When the leaves of the bridge were erected the center trusses had a tendency to creep together. That was before the full loads were on the cross girder. This, of course, was due to the fact that the trunnions were not horizontal, which was caused by the levels on the shims. However, after a number of panels had been erected the diaphragms were placed, this corrected the line, and as the full loads came on the trusses they settled down into the horizontal position so when all the loads are on the bridge the bearings for all the trunnions will be on a horizontal line.

The bridge is figured for two cases; one case is the bridge closed and the other bridge open, or fully opened. For case of bridge closed the dead loads are figured on the bridge as a cantilever with the reaction at the trunnion. Live loads are also figured for two cases; one, the reaction being taken at the river pier and the anchor column, and the other case where there is an additional reaction caused by the impact. What we formerly used is $\frac{100}{nl} + 300$ where n is, I believe, one-tenths of the weight of the loaded length, and l is the length. Then the stresses are combined and placed in one column and in the next column, if there be any reversal for a combination of the stresses just mentioned, fifty per cent of that reversal is placed in the second column and then the total governing stress figured for this case and tabulated.

For the case of bridge opened or fully opened the dead loads are figured for bridge closed, or nearly closed. To these stresses twenty per cent is added for vibration, to which are added stresses due to number of pounds exerted on the exposed area of the leaf. These are summed up algebraically. If there be any reversals for this case they are placed in another column for this particular division, and a total combined stress figured for this case. Then the combined stress is figured for the bridge closed, and the combined stress for the case of bridge opened or fully opened. If there be reversals on these two cases, then six per cent of that reversal is taken and placed in a column for the final consideration of combined stresses.

Then in another column are placed the governing stresses. They are picked out and the one giving the largest stress is tabulated,—both the tension and compression.

For the determination of the counter-weight for the leaves it is necessary to find the center of gravity of every component part of the trusses and work these back into the final center of gravity of the leaves exclusive of the counter-weight. For this particular bridge the center of gravity of the leaf exclusive of counter-weight is about 25 or 26 feet ahead of the trunnion, and about 9 feet over a horizontal line through the trunnion. The weight of the leaf exclusive of the counter-weight was about 2,500,000 pounds for one-half of each leaf and the corresponding counter-weight required 1,500,000 for each half of each leaf. The center of gravity of the counter-weight box is about thirty feet back of the trunnion, and, I don't just know what the distance is below the horizontal line through the trunnion. The center of gravity of the leaf exclusive of the counter-weight is quite high, and this causes the counter-weight necessary for balancing to be placed in a very low position in the box. The counter-weight for these leaves was made of common concrete at 145 pounds for the upper and front part of the boxes and for the lower left hand corner of the boxes of composition concrete weighing 300 pounds per cubic foot. This composition concrete is made of punchings and grout. The inside trusses tended to come together, which was due to the fact that the trunnions were supported on bevel shims and caused a little concern at first, but when the matter was explained this was ironed out all right, and after a number of panels had been placed diaphragms were inserted between the trusses, which corrected the alignment from that point to the end of the leaves. When the leaves were lowered the trusses were out of line laterally, I believe, about three inches, but steamboat ratchets were immediately placed and by means of cables the ends were very readily drawn over, and within a short time the four trusses fit perfectly.

MECHANICAL AND ELECTRICAL EQUIPMENT.

In the plane of the rear arms of the trusses are built racks which are of about 19 ft. 9 in. radius. These racks are engaged by pinions on frames which are located on the outside of the outer trusses. The frames at these points have three counter shafts. The last counter shaft is connected by means of bevel gearing to a line shaft which is carried back into the machinery room and thence over to the motor stand. The motors are at the ends of the line shafting, keyed in with bevel gears which are a part of the equalizer, vertical bevel gears, which engage bevel gears at right angles to the vertical gears, which in turn are fastened by means of pins into a large spur gear, which is engaged by the pinions on the motor or armature shafts. The armature shafts are continuous right straight through both motors, the motors being raised in pairs.

A provision is made on the motor shafts for fleible couplings to insure proper working of the motors and the pinions that engage the equalizers are extended up and are engaged by clutches. These clutches were provided to permit of an easy changing of the motors, it being considered necessary to alternate the use of the motors from week to week, and the particular reason for putting in clutches there was to avoid the necessity of going to a machine shop or the municipal plant to get the necessary craftsmen to take out the bolts if bolts were provided, which would cause considerable delay. The bridge operators are not supposed to take any bolts out of any couplings or any other apparatus. The pinions on the armature shaft are always in mesh and the ones not engaged run as idlers.

On the second counter-shaft is provided an air operated brake. The machinery for operating the barriers is located on the river pier. Each half of the leaf is operated by one motor, that is, each half of the rear lock machinery of each leaf is operated by one motor. The bridge is made for operating all of the various functions of the bridge by motors. In case one half of the bridge may be damaged due to impact by boat it would be necessary to raise this leaf for repairs, and in order not to delay traffic an arrangement is made to operate the other half.

The shoes of the air brake are operated by means of air cylinders which are direct acting. These cylinders are controlled, the admission of air into these cylinders is controlled by magnet switches operated from the operator's house. Near the cylinders are placed auxiliary tanks to insure the proper supply of air. In the houses on both sides of the river are placed two automatic air compressor plants. Each unit has a capacity I believe to displace about fifty feet of cubic air per minute. The motors and the compressors have a herring bolt pinion and gear, and arrangement is made by means of an automatic governor to insure pressure in the main air tank at the plant of about ninety pounds pressure, or any pressure necessary to have about sixty pounds pressure at the brake cylinders themselves.

The shoes of the hand operated brake are operated by means of toggle arrangement as in case of the air brake, which, in turn, is operated by a cable which is deflected around over pulleys and finally led around to the brake stand in the houses. In addition to these brakes the emergency brake, air operated, is provided.

The electric control equipment for the bridge comprises the operator's house, the operator's room and a control room immediately below the operator's room and a gateman's house on each side of the river on the lower level at the center of the street back of the counter-weight pits. In the control room are placed the necessary resistances for controlling the currents in the main operating motors, the center lock motors, etc.; also panel boards on which are mounted the relays, contractors and double throw switches and other electrical apparatus. In the operator's room, which is arranged in convenient manner and somewhat in accordance with the sequence of operations, are placed the controllers for the barriers, which are of the drum type. The controllers for operating the emergency brake and also the service air brake on the gear train are located near the stand of the operator. Also near the stand of the operator are provided the master controllers for operating the center locks and rear locks and also the main operating motors. The controllers for the operating of the main motors, also the center lock and rear motors, are of the magnetic type and have provision for certain points of acceleration which by means of magnetic switches operate the contacts and relays located on the control panel boards in the control room. The barrier controls are of the drum type, the fingers of which operate the current directly, are provided as described.

The brake stand for operating the hand operated brake is on the right hand side of the operator and near the side of the house, near the roadway side of the house. Provision has been made for this bridge, as I believe in the Monroe Street bridges and the Franklin-Orleans bridge, for a bench board. On this are mounted switches which control the cut-outs for the various interlocks, also the signals and bells and the double throw switch which is mounted on the control board in the control room. When a steamer gives the operator the signal to open the bridge—and in this particular bridge the main operator is located on the north side of the river, the north operator signals his gateman and also the operator on the south side of the river, who in turn signals his gateman. After these gatemen return the signal to the operators—the purpose of these signals being to call the operators and gatemen to their stations—after the main operator has received the signal back that these men are at their stations he sends another signal out which is for the purpose of closing the gates. The signal gates are lowered first on the side of the ingoing traffic, that is, both on the upper and lower levels, and when the signal gates on the side of ingoing traffic are lowered they give current for operating the barriers on those particular sides, and after these are lowered and the traffic goes off the other side of the bridge then the signal gates on that side are lowered and they give current for the operation of the barriers and when the barriers are lowered on both levels current is furnished for operating the rear locks. In the meantime the north

operator can operate the center locks of the bridge. When the center locks are operated they give current for the operation of the rear locks, so we have the rear locks interlocked with both the barriers and the center lock. When the center lock has been drawn the interlocking arrangement is divided and each leaf is operated independently. After the rear locks are withdrawn then the current—and of course in each of these pieces of apparatus limit switches are provided which control the travel of the mechanical parts, and of course in the extreme positions operate the switches that control the interlocking. When the rear locks are withdrawn current is released for the main operating motors and these can be operated in the usual manner.

In lowering the bridge the sequence of operation is somewhat similar except that the rear locks must be placed before the center lock bolt is driven.

In the plane of each truss of each leaf are placed rear locks which are operated by trains of gears mounted on the river pier. To these gears are connected a toggle arm which engages a casting on the rear of the counter-weight box. The live load that comes on these locks is about 138,000 pounds. These locks are operated by ten horse power motors, and it is more or less of an arbitrary assumption of what should be provided in the way of power, but experience has shown that ten horse power motors are the proper thing to use, and the loads under which these operate are those loads due to raising the leaf and placing it back in position. At each lower floor at the center of the bridge are provided center-locks. These locks are operated by four or five horse power motors and so arranged that two locks of each span can be operated independently. The machinery for operating the locks is placed below the lower level floor and the gearing is connected to rods which in turn operate connects here which push out the bolts. The principal reason for the provision for center-lock apparatus is to insure that when a live load is on one span that the other span will deflect a corresponding amount so there will be no unevenness in the break of the bridge floor at the center. Emergency brakes are provided, one at each truss at the rear end of the counter-weight end. The casings or brake shoes are supported on projections on the pit walls, the side walls and the center wall of the pit. These tracks are gripped by means of shoes which are operated by a device very similar to a pair of shears. The outer end of these shears is operated by means of levers, at the end of which is provided a toggle arrangement operated by an air cylinder. The air entering the cylinder is controlled by means of a magnetic air valve which is controlled from the operator's house. The cylinders are about 10 in. x 10 in. and operate with 60 pounds pressure. The force on the side of the track, on each side, I believe, is about 95,000 pounds. The actual cantilever force is about 85,000 pounds. This, of course, goes down through these various levers so that at the cylinder six or eight thousand pounds is necesary, it would be less than that,—the diameter of these cylinders is about ten inches and they operate on 60 pounds pressure.

The machinery for operating this device is fastened to casings which are attached to the counter-weight box. It is an additional reason for braking, and on a bridge of this character it was considered justifiable, to go to this expense to provide everything possible that would make for safety. The leaves as erected have been controlled very easily by means of the hand operated brake, but, of course, when the floors are placed and these leaves are raised and exposed to high wind pressure, it will be necessary, or at least it will be a greater assurance of safety, and you will have more to rely upon than merely one hand operated brake, so we have for each leaf of this bridge two hand operated brakes, two service air brakes that are mounted on the gear trains and four emergency air brakes mounted on the rear end of the tail arms that are firmly imbedded in the side walls of the counter-weight pits.

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TECHNICAL PAPERS

Deflections of Beams by the Conjugate Beam Method.

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I. INTRODUCTION.

1. *An Introductory Discussion of the Standard Methods of Finding Deflections of Beams.*—Three methods are commonly used in determining deflections of beams: The first is the purely analytical "double integration" method. The second is the graphical "funicular polygon" method or "string polygon" method. The third is the semi-geometrical "moment area" method. Each of these three methods has a particular field where it is most useful. By the analytical double integration method the equation of the elastic curve is determined; namely, by integration of an "equation of flexure" of the form $d^2y/dx^2 = \pm M/EI$. If the equation of the elastic curve (the deflected center-line) is the result called for, then it is natural, at least in a number of cases, to apply this method, which leads to fairly simple solutions when the load is of a simple nature. On the other hand, when the load is more complex, then the method would in most cases require a rather elaborate determination of integration constants, and this feature is undesirable. For example, six concentrated loads on a simple beam, dividing it into seven sectors, would require the determination of fourteen integration constants. The analytical integration method was used as early as 1744 by Euler,** and is important because, both logically and historically, it is the fundamental method from which the others have been derived.

The second method, that of the string polygon, was developed by O. Mohr† who showed in 1868 that the deflected curve may be found as a string curve or string polygon. This graphical method is useful when the load is complex, consisting, for example, of a large number of concentrated forces. A disadvantage of the method is that it gives results only in one specific case at the time. Moreover, the method is limited to the degree of approximation which can be obtained by graphical construction.

The third method, the moment area method, has appeared in more than one form, and it has proved itself useful in a large variety of both simple and complicated cases. It makes it possible to determine the deflection at one definite point without first finding the equation of the whole elastic curve. At the same time the method is well adapted for the purpose of determining formulas for the deflection at any point, that is, of determining the equation of the elastic curve. The moment

†O. Mohr, Beitrag zur Theorie der Holz und Eisenkonstruktionen, Zeitschrift des Architekten- und Ingenieur-Vereines zu Hannover, 1868.

*Assistant Professor of Theoretical and Applied Mechanics, University of Illinois.

**Euler, Methodus inveniendi lineas curvas, etc., Lausanne, 1744, see Additamentum "De curvis elasticis."

area method was deduced in its first form by O. Mohr (1868)†. When proving the string polygon method, he recognized that when both the bending moments and the deflections can be found by means of string polygons, then it would also be possible to determine deflections as if they were bending moments. Mohr showed how the moment area principle derived in this way could be used with advantage in finding the deflections of simple beams, and afterward he applied the results in an analysis of continuous beams. At about the same time, or not much later, C. E. Greene*, at the University of Michigan, discovered the moment area principle in a distinctly different form. Greene's principle determines the deflections of a cantilever, or in general, the deflections of any beam, measured from any tangent to the elastic curve. These deflections are found to be proportional to moments of areas in the moment diagram. The basis of the proof is that the double integrals which express deflections can be interpreted as proportional to such moments of moment areas. Evidently, Mohr's and Greene's moment area principles are different. Each has its field where it is most useful: for example, Mohr's principle is preferable in the case of simple beams, Greene's in the case of cantilevers.

Later Mueller-Breslau** extended Mohr's original moment area principle in such a way that it became directly applicable to beams with any type of supports, and also to trusses. The extended method, applied to beams, includes as special cases both Mohr's and Greene's original principles. One of its main features is the use of an additional beam in which the bending moments are equal to or proportional to the deflections of the given beam. This beam, introduced by Mueller-Breslau, will here be called the "conjugate beam," and, accordingly, we shall call the extended moment area method the " conjugate beam method."

The pages which follow will be devoted to a discussion of the "conjugate beam method," its derivation, and its use in finding deflections of statically determinate beams and in the general analysis of statically indeterminate beams. In the treatment of statically indeterminate beams a method of selecting the conjugate beams will be used which departs slightly from customary methods. In other respects it is the plan to follow the usual way of presenting the subject.

The conjugate beam method requires an apparatus of investigation which is, of course, slightly more complicated than, for example, that of Greene's original principle. But when once established the operation of the extended method is in any case as simple as that of Greene's principle, and, in addition, the extended method has the advantage of a much wider range of direct applicability than the original more limited principles. This will be shown on the pages which follow.

2. *Definitions and Notation.*—We shall speak about the *given beam* and about the *conjugate beam*. The *given beam* is the beam of which the deflections are to be determined. The *conjugate beam* is a fictitious beam which corresponds to the given beam, and which is introduced for the purpose of analysis. It has the same length as the given beam. It is defined as a beam which is supported and loaded in such a way that its moment diagram becomes identical with the diagram of the deflections of the given beam. Or, by definition, the deflections of the given beam can be found as bending moments in the conjugate beam. Points on the two beams having the same distance, say, from the left end, are considered as "corresponding" or as "the same."

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†See the paper just quoted. See also O. Mohr, Abhandlungen aus dem Gebiete der technischen Mechanik, 2 ed., 1914, pp. 342-374.

*According to J. E. Boyd, Strength of Materials, ed. 1917, p. 153, Greene began teaching the moment area method in 1873.

**See H. Mueller-Breslau, Beitrag zur Theorie des Fachwerks, Zeitschrift des Architekten- und Ingenieurvereines zu Hannover, v. 31, 1885, p. 418, also his "Graphische Statik," v. II., 1, ed. 1892, pp. 99-120.

The following notation will be used:

w=distributed load on the given beam, per unit length; w is considered positive downwards.

V=vertical shear in the given beam, equal to the sum of vertical forces to the left of the section considered, with these forces considered positive upwards.

M=bending moment in the given beam; M is considered positive when causing compression at the top, tension at the bottom.

w', V', and M'=load per unit length, shear,, and bending moment, respectively, in the conjugate beam; they are considered positive in the same directions as w, V, and M.

θ=the slope of the elastic curve (that is, of the deflected center line), of the given beam; θ is considered positive clockwise.

y=deflection of the given beam, considered positive downwards.

x=horizontal distance, positive toward the right.

L=length of span.

EI=modulus of elasticity times moment of inertia of cross-section.

3. *The Six Diagrams Characterizing the Action of a Beam.*—Fig. 1 shows a simple beam which carries a distributed load w given by the diagram shown at top.

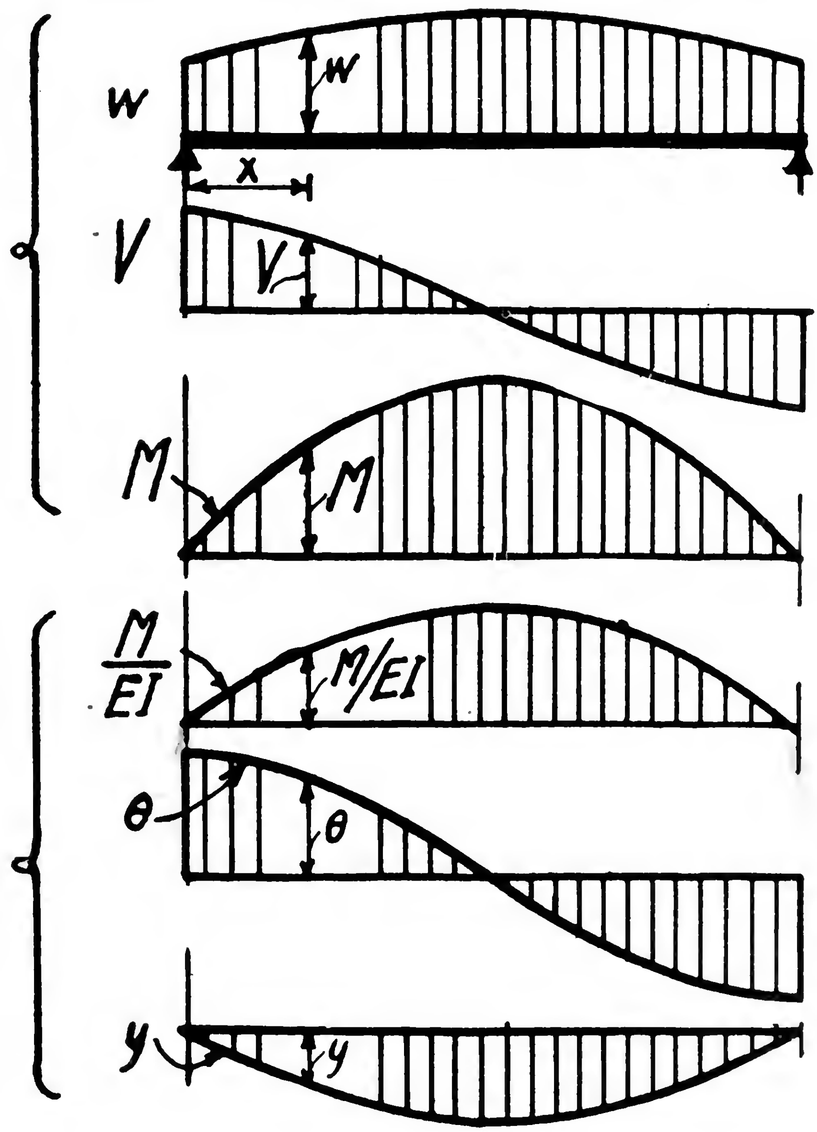

Fig. 1.

The action of the beam may be characterized by the six diagrams shown in Fig. 1. They are placed above one another, with common abscissas x. We shall consider these diagrams in two separate groups with three in each:

In the first group the ordinates are:
w (=load), V (=shear), and M (=bending moment), respectively.

In the second group the ordinates are:
M/EI, Θ (= slope), and y (= deflection), respectively.

Also in the case of any other type of beam,—cantilever, fixed, continuous, etc.,—the action of the beam may be described by means of six diagrams of this kind. In any case the following relations will exist between the diagrams:

In the first group:

$$V = \frac{dM}{dx} \quad ; \qquad -w = \frac{dV}{dx} = \frac{d^2M}{dx^2} \tag{1}$$

In the second group:

$$\theta = \frac{dy}{dx} \quad ; \qquad -\frac{M}{EI} = \frac{d\theta}{dx} = \frac{d^2y}{dx^2} \tag{2}$$

The relation $\Theta = dy/dx$ is simply a statement that the slope is the derivative of the deflection. The other relations occur in the usual theory of flexure. The negative sign of $-M/EI$ in equation (2) is in accordance with the choice of the positive direction of the deflections y (positive downwards).

The relations (1) and (2) between the diagrams may be interpreted graphically or geometrically as follows:

(1) The shear is the slope in the moment diagram. Minus the load per unit length is the slope in the shear diagram. (2) The ordinate Θ is the slope in the y-diagram. Minus the ordinate M/EI is the slope in the Θ-diagram.

The factor EI determines the relation between the diagrams of the first group and the diagrams of the second group. The factor EI may be a constant, or it may vary from point to point. Usually we shall assume EI=constant, in which case the ordinates in the M/EI-diagram are proportional to the ordinates of the M-diagram. Then these two diagrams will be similar, or, with some particular choice of scales, they will be identical.

4. *The Moment Area Principle and the Load Diagram of the Conjugate Beam.*—By our definition of the conjugate beam its bending moments M' are to be equal to the deflections y of the given beam, that is,

$$M' = y \tag{3}$$

By a proper loading of a beam it will always be possible to make its bending moment diagram take any given shape. The problem is then to find the particular load diagram w', and some particular method of support, which would cause the moments in the conjugate beam to be equal to the deflections of the given beam, such as stated in equation (3). We shall first determine the load diagram, w'. Equations (1) serve this purpose. As they apply to any beam, we can make them apply to the conjugate beam by substituting the valves w', V', and M' for w, V, and M. That is, we have:

$$V' = \frac{dM'}{dx} \quad ; \qquad -w' = \frac{dV'}{dx} = \frac{d^2M'}{dx^2} \tag{4}$$

Substituting $M' = y$ in accordance with (3) and comparing with (2) we find the solution:

$$w' = M/EI \tag{5}$$
$$V' = \theta \tag{6}$$

These two relations combined with (3),

$$M' = y \tag{3}$$

express the moment area principle, which may now be stated as follows: *The load diagram of the distributed loads acting on the conjugate beam is the same as the M/EI-diagram of the given beam. The slopes of the given beam are equal to the shears of the conjugate beam. The deflections of the given beam are equal to the bending moments of the conjugate beam.* The "moment areas" in question are, strictly speaking, not moment areas, but areas of the M/EI-diagram. It is these areas which are acting as loads on the fictitious "conjugate beam."

It remains for us to determine the character of the supports of the conjugate beam.

5. *The Supports and Other Special Points of the Conjugate Beam.*—Equation (5) gives complete information as to the forces acting on the conjugate beam on any stretch within which there is continuity in the deflections and slopes of the given beam. On the other hand, at special points, such as at the ends, or where the given beam has a hinge, there may be, and will be, in general, a discontinuity in the application of equations (2) and (4). Consequently, at such points there may be forces acting, other than the distributed forces given by equation (5). There may be concentrated forces or couples. These forces or couples must counterbalance the distributed load of the M/EI-diagram, and might therefore be produced as reactions supplied by the supports, provided these supports are placed properly. The supports of the conjugate beam may be different from those of the given beam. We shall indicate rules by which the character of the conjugate beam, its supports, hinges, etc., may be determined. In some cases there may be more than one solution, but in such cases we shall choose the simplest possible type of conjugate beam.

The following rules may be indicated: At points where the deflections or the slopes of the given beam have definite given values, the moments and the shears of the conjugate beam must be made to assume those definite values. And especially, *at points where the deflection of the given beam is zero, the moment in the conjugate beam must be made zero, and where the slope of the given beam is zero, the shear in the conjugate beam must be made zero.* This law leads to five specific rules for the selection of supports of the conjugate beam, and for the placing of its hinges, free ends, and other special points. Fig. 2 will illustrate the five cases, which are num-

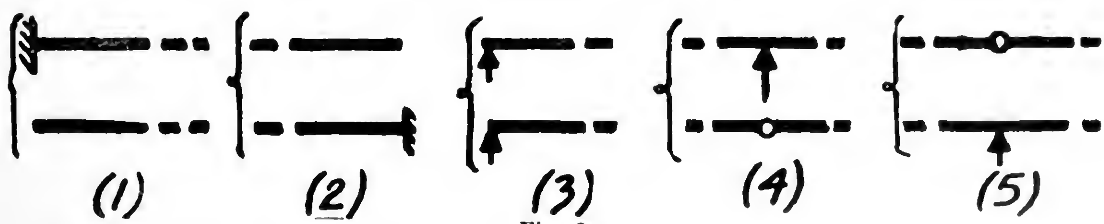

Fig. 2.

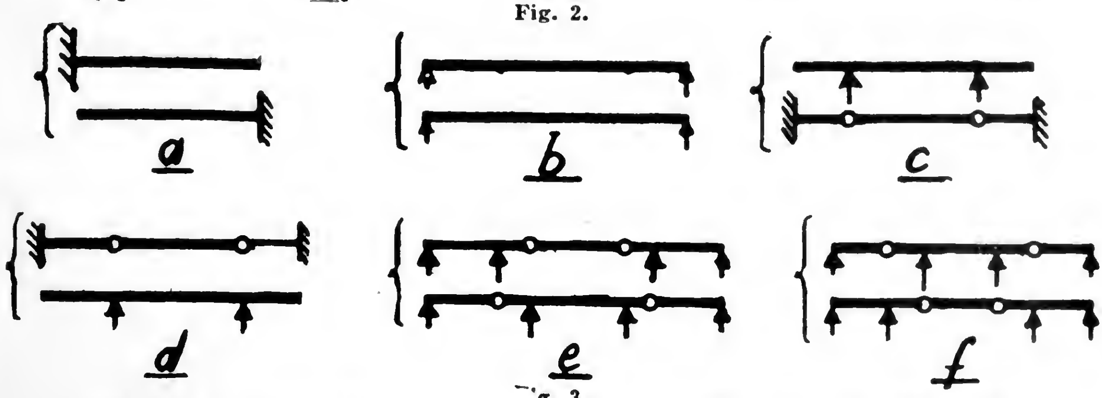

Fig. 3.

Upper Line: Given Beam. Lower Line: Conjugate Beam.

bered in the figure in the order in which they will be discussed; in each case a part of the given beam is shown above in the figure, while the corresponding part of the conjugate beam is shown directly below:

(1) A rigidly fixed end of the given beam (case (1), Fig. 2) is a point where its deflection and slope are zero. At such a point the conjugate beam must have zero bending moment and zero shear. This condition is established by letting the conjugate beam haye a free unsupported end at that point. We might, instead of that, place a simple support at the point and then stipulate that the reaction at the point must be zero, but the former solution appears to be the simpler one and will be given the preference.

(2) A free end of the given beam, for example, of a cantilever, is a point where both the deflection and the slope may be different from zero (case (2), Fig. 2). Correspondingly, it must be arranged that the bending moment and the shear in the conjugate beam at that point may become different from zero. A fixed-end support of the conjugate beam at that point is the simplest arrangement which will cause an end moment and an end shear with the values which are necessary for maintaining equilibrium.

(3) A simple support at the end of the given beam (case (3), Fig. 2) causes the deflection at that point to be zero, but allows the slope to become different from zero. That is, in the conjugate beam the conditions at that point should cause the moment to be zero, but should provide for a shear which may be different from zero. The simplest way of establishing such conditions is by letting the conjugate beam end at the point and there have a simple support. The reaction from that simple support is equal to the shear in the conjugate beam, and must therefore be equal to the slope of the given beam.

(4) Next, consider a simple support not at the ends (case (4), Fig. 2). The given beam is assumed to be continuous over that support. The deflection at the point is zero. The slope may be different from zero, but must have the same value immediately to the left and to the right of the point. Therefore, in the conjugate beam the moment at the point must be zero, and the shear may have a value other than zero, but must have the same value immediately to the left and to the right of the point. An unsupported hinge in the conjugate beam is the simplest arrangement by which this condition can be established.

(5) A hinge in the original beam (see case (5), Fig. 2) is a point where the two adjoining parts must have the same deflection but may have different slopes. Hence the conjugate beam has the same moment immediately to the right and to the left of the point, but may have different shears. This condition is established when the conjugate beam has a simple support at the point, furnishing a single-force reaction only.

It is seen that Fig. 2 represents completely the five rules which have just been indicated.

6. *The Conjugate Beam in Some Definite Cases.*—The five rules illustrated in Fig. 2 will now be applied in a number of definite cases. Fig. 3 shows the application to the important types of statically determinate beams. In each case the given beam is shown above, the conjugate beam right below. In the case of the cantilever in Fig. 3*a*, rule (1) applies to the left end, rule (2) to the right end. Hence, the conjugate beam corresponding to a cantilever is a cantilever fixed at the opposite end. We verify the result that the conjugate beam must be fixed or held at the right end, by noting that the beam must be free at the left end, and that it must be in equilibrium.

Fig. 3*b* shows a simple beam. Rule (3) applies to both ends. The result is that the conjugate beam is a simple beam, like the given beam. That the concen-

trated forces acting at the ends of the conjugate beam can be found as reactions from simple supports, follows from the fact that the conjugate beam must be in equilibrium.

Other cases of statically determinate beams are shown in Fig. 3*c, d, e,* and *f*. The application of the rules of Fig. 2 in each separate case is easily recognized. It should be noted that in all these cases of statically determinate beams the conjugate beams are statically determinate. Because of this property it becomes unnecessary to indicate the particular elastic properties of the various pieces of the conjugate beam. It is enough to state that the individual pieces of the conjugate beams may be considered as rigid bodies.

A certain reciprocity may be noted in Fig. 3; if the conjugate beam in any of the cases were made the given beam, then the original given beam would become the conjugate beam. In other words, in all these cases the given beam is the conjugate beam of the conjugate beam. This reciprocity is found already in Fig. 2 where rules (1) and (2) are reciprocal, likewise (4) and (5), while (3) may be considered as its own reciprocal.

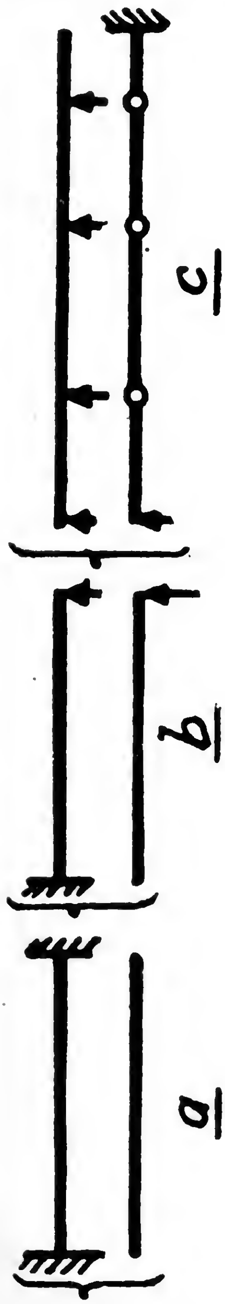

Fig. 4.

Fig. 4 shows three typical cases of statically indeterminate beams; that is, beams which have too many supports to allow the determination of the reactions and of the shear and moment diagrams by means of the ordinary statical conditions alone, without taking the elastic deformations into account. In Fig. 4 the given beams are shown above. The corresponding conjugate beams, derived in each case by the rules of Fig. 2 are shown below. The given beam in Fig. 4*a* is fixed at both ends. An application of rule (1) to both ends gives a conjugate beam which is free at both ends.

This conjugate beam is "incompletely supported" in the sense that unless the load diagram has a special character, the beam could not be in equilibrium. That is, the load diagram, in this case the M/EI-diagram, must be adjusted, like the buoyancy forces on a floating body, in order to establish equilibrium. It will be shown later that this process of adjustment of the M/EI-diagram supplies the remainder of the conditions which are needed in determining the unknown reactions. Or, the conditions of equilibrium of the conjugate beam furnish a means of determining not only the deflections of the given statically indeterminate beam, but also its moments, shears, and reactions. Similar remarks may be made about the conjugate beams in Fig. 4*b* and *c*, which are also "incompletely supported." In Fig. 4*b* the given beam is fixed at the left end, simply supported at the right end. An application of rule (1) to the left end, rule (3) to the right end, leads to a conjugate beam which is simply supported at the right end only. Equilibrium is secured by a particular adjustment of the M/EI-diagram. In Fig. 4*c* the given beam is continuous over three spans and has an overhanging end to the right. Rules (3), (4), and (2) apply at the special points. Instead of using the unsupported hinges in Fig. 4*c* one might place supports under them and then stipulate that the reactions from those supports must

be zero. However, we prefer here to indicate as "the conjugate beam" that which is shown in Fig. 4*c* and which has unsupported hinges.

7. *Deflections Measured from Other Lines than from the Original Undeflected Center Line.*—Assume that it is desired to measure the deflections of the simple beam *AB* in Fig. 5 from the chord *CD*, where *C* and *D* are points of the beam, deflecting with the beam. The fundamental equations (2) apply to the deflections from *CD*. Furthermore, as far as the deflections from *CD* are concerned, the beam may be considered as simply supported on *CD* at points *C* and *D*. The actual reactions at *A* and *B* may then be considered as external forces acting at the free ends of the beam (any reaction may be considered as an applied external load). The corresponding conjugate beam is shown below in Fig. 5. The load acting on the conjugate beam is the M/EI-diagram of the original beam, supported at *A* and *B*.

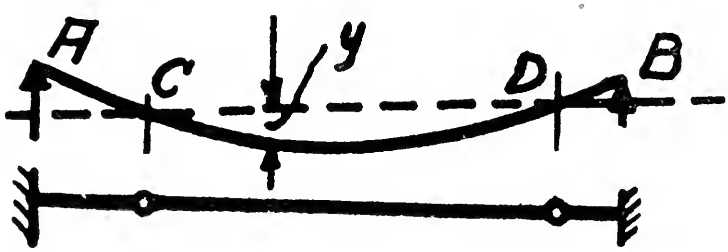

Fig. 5.

A similar example is illustrated in Fig. 6, where the deflections *y* are measured from the tangent at *C*. After the actual bending moment at the fixed end *A* has been determined, this bending moment is considered as an external couple. Then the beam may be analyzed as if supported at *C*. The corresponding conjugate beam consists of two cantilevers, and is shown below. In this way the deflections of any beam from any of its tangents may be found. That is, Greene's principle, determining the deflections from the tangent, is covered as a special case by this particular application of the principle of the conjugate beam.

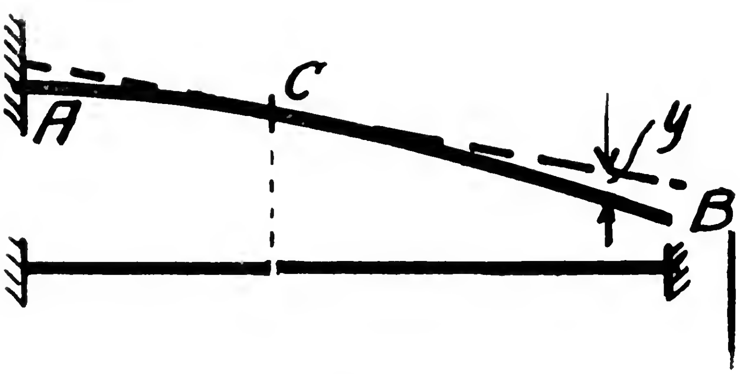

Fig. 6.

II. STATICALLY DETERMINATE BEAMS.

8. *General Remarks.*—We are now ready to apply the conjugate beam method to a number of definite cases. We begin with a study of deflections of statically determinate beams. In the specific cases treated it will be assumed that unless otherwise stated, the stiffness factor *EI* is a constant throughout the length of the beam. Also, unless otherwise stated, the deflections and slopes will be measured relative to the undeflected center line of the beam.

9. *Cantilevers.*—A cantilever of length *L*, fixed at the left end, will be considered. The conjugate beam was shown to be a cantilever fixed at the opposite end,—such as indicated in Fig. 3*a*.

A. *Concentrated load at the end.*—The M/EI-diagram is a triangle, as shown in Fig. 7. The bending moments are negative. That is, the M/EI-load is a load upward on the conjugate beam. The conjugate beam, which is fixed at the right end, is shown in Fig. 7, with the M/EI-load acting on it. Since that load acts upwards, it gives positive moments and shears in the conjugate beam. This result agrees with the fact that the slopes and deflections of the given beam must be positive (with the previously indicated notation, the deflections are positive downward, and the slopes are beam occur at the free end. The slope of the given beam at the free end is equal to the shear at the fixed end of the conjugate beam, or equal to minus the area of the M/EI-diagram, or

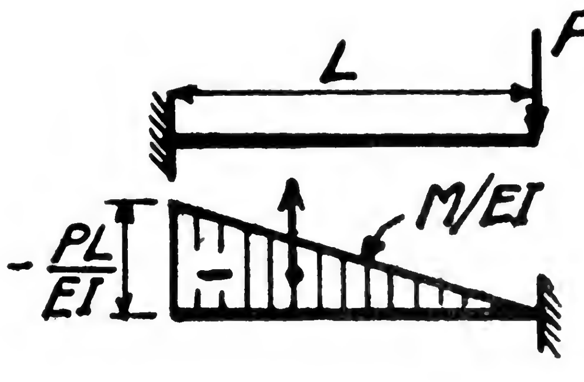

Fig. 7.

$$\theta_{max} = \frac{1}{2}\frac{PL^2}{EI} \tag{7}$$

The deflection at the right end of the original beam is the moment at the fixed end of the conjugate beam. The resultant of the M/EI-load passes through the centroid of the M/EI-diagram; that is, it has a moment arm equal to $(2/3)L$ with respect to the right end. The M/EI-load acts upwards, giving positive moments in the conjugate beam; or, positive deflections in the given beam. The maximum moment in the conjugate beam, equal to the right end deflection in the given beam, is then

$$y_{max} = \left(\frac{1}{2}\,\frac{PL^2}{EI}\right)\left(\frac{2L}{3}\right) = \frac{PL^3}{3EI} \tag{8}$$

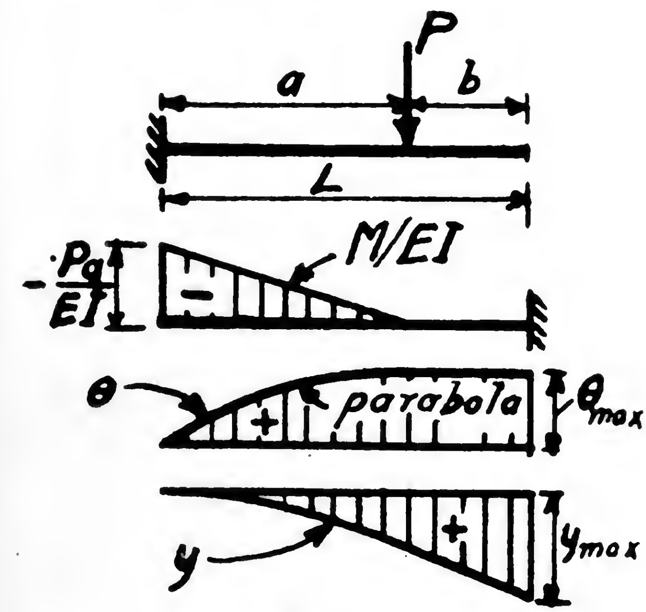

Fig. 8.

Slopes and deflections at other points may be found in a similar manner, and thus the complete slope and deflection diagrams may be obtained.

B. *Cantilever loaded by a concentrated force P at any point.*—The notation for distances is given in Fig. 8, which shows the given beam at top, and the conjugate beam, loaded with the M/EI-diagram right below. The maximum slope, as in the preceding case, is equal to minus the area of the M/EI diagram, that is,

$$\theta_{max} = +\frac{1}{2}\frac{Pa^2}{EI} \tag{9}$$

The moment at the fixed end of the conjugate beam, that is, the deflection at the free end of the given beam, is

$$y_{max} = +\frac{1}{2}\frac{Pa^2}{EI}\left(\frac{2}{3}a+b\right) \tag{10}$$

The shapes of the complete θ and y-diagrams are shown below in Fig. 8.

C. *Cantilever with load uniformly distributed.*—Fig. 9 shows the given beam above, and the conjugate beam, loaded with the M/EI-diagram, below. The parabolic area of the M/EI-diagram has an average ordinate equal to one-third of the greatest ordinate. Its centroid is at a distance $(3/4)L$ from the right end. Hence we find for the right end:

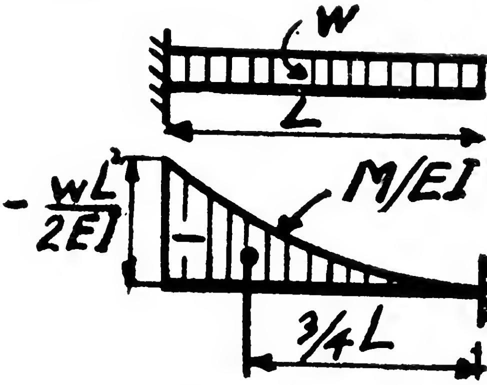

Fig. 9.

$$\theta_{max} = \frac{1}{3}\left(\frac{wL^2}{2EI}\right)\cdot L = \frac{wL^3}{6EI} \tag{11}$$

and

$$y_{max} = \left(\frac{wL^3}{6EI}\right)\cdot\frac{3}{4}L = \frac{wL^4}{8EI} \tag{12}$$

10. *Simple Beams.*—A simple beam with span L will be considered. The conjugate beam was shown to be a simple beam,—see Fig. 3*b*. This is the particular case in which the conjugate beam is the same as the given beam. Mohr's original theory was applied to that case. The action under various types of load will now be investigated.

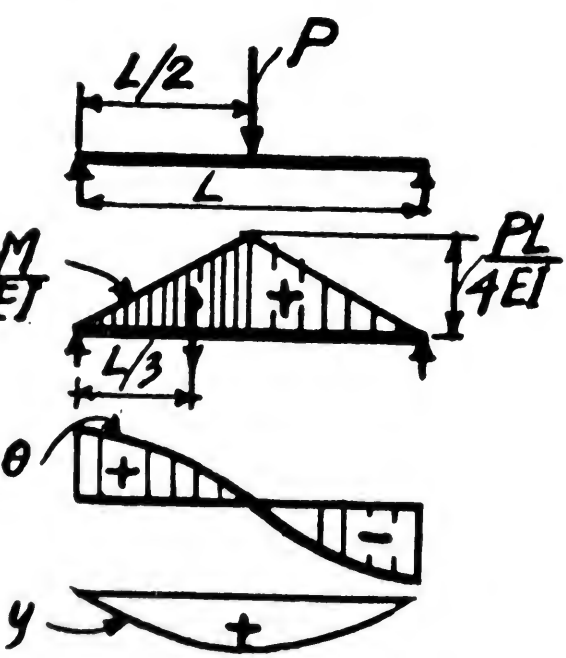

Fig. 10.

A. *Simple beam, concentrated load P at center.*—The M/EI-diagram is a triangle. It is shown in Fig. 10 as a load acting on the conjugate beam. The maximum slope in the given beam occurs at the left end. It is equal to the left end shear in the conjugate beam. This left end shear is equal to the reaction, which, on account of the symmetry, is one-half the area of the M/EI-diagram. Hence the following expression for the maximum slope:

$$\theta_{max} = \frac{1}{2} \cdot \frac{L}{2} \cdot \frac{PL}{4EI} = \frac{PL^2}{16EI} \quad (13)$$

The centroid of the left half of the M/EI-diagram is one-third of the span from the left end; hence the maximum moment in the conjugate beam, or the maximum deflection of the given beam, is expressed as

$$y_{max} = \frac{PL^2}{16EI} \cdot \frac{L}{3} = \frac{PL^3}{48EI} \quad (14)$$

B. *Simple beam, two equal concentrated loads, symmetrically placed.*—Fig. 11 gives the notation and shows the trapezoidal M/EI-diagram, which acts as a load on the conjugate beam. The slope at the left end and the deflection at the center are determined as the left end reaction and as the moment at the center of the conjugate beam. The values are:

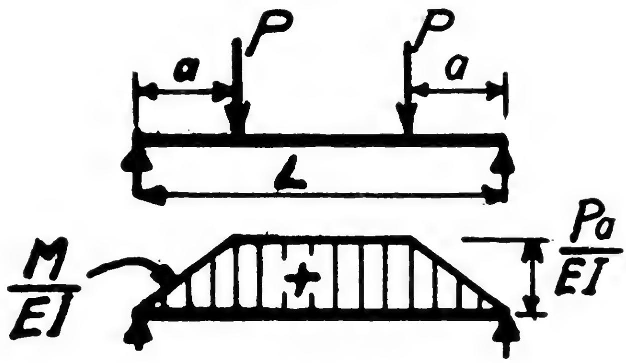

Fig. 11.

$$\theta_{max} = \frac{Pa\,(L-a)}{2EI}, \qquad y_{max} = \frac{Pa}{24EI}\left(3L^2 - 4a^2\right) \quad (15)$$

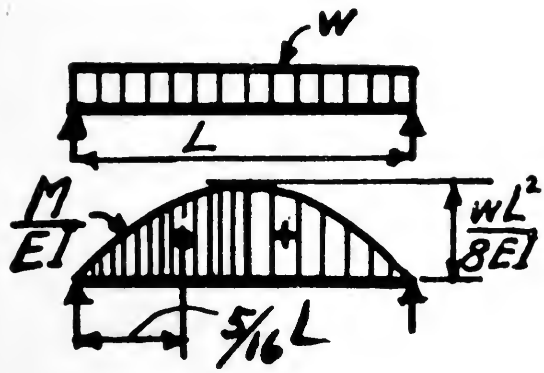

Fig. 12.

C. *Simple beam uniformly loaded* (Fig. 12).—The moment diagram is a parabola with the maximum ordinate $M = (1/8)wL^2$. The end slope is one-half the area of the M/EI-diagram, that is,

$$\theta_{max} = \frac{2}{3} \cdot \frac{wL^2}{8EI} \cdot \frac{L}{2} = \frac{wL^3}{24EI} \quad (16)$$

The centroid of the left half of the parabolic area is $(5/16)L$ from the left end, that is, the moment in the conjugate beam at the center, or, the maximum deflection of the given beam, is

$$y_{max} = \frac{wL^3}{24EI} \cdot \frac{5L}{16} = \frac{5\,wL^4}{384EI} \quad (17)$$

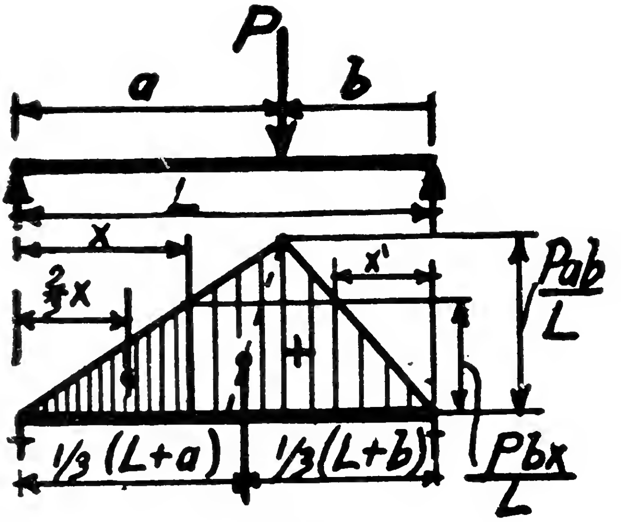

Fig. 13.

D. *Simple beam, concentrated load at any point.*—Fig. 13 gives the notation. The M/EI-diagram is a triangle with altitude $Pab/(EIL)$. The horizontal distance of the centroid of the triangle, measured from the right end, is $(1/3)\ (L+b)$; hence, the left end shear in the conjugate beam, or the left end slope in the given beam, is

$$\theta_A = \frac{L}{2} \cdot \frac{Pab}{EIL} \cdot \frac{L+b}{3L} = \frac{Pab\ (L+b)}{6EIL} \tag{18}$$

The moment in the conjugate beam or the deflection of the given beam at the distance x from the left end, when x is assumed less than a, is then

$$y = \theta_A \cdot x - \left(\frac{Pbx}{EIL} \cdot \frac{x}{2}\right) \cdot \frac{x}{3}$$

or

$$y = \frac{Pbx}{6EIL}\left(a(L+b) - x^2\right) \tag{19}$$

To the right of the load the deflection may be found by replacing x in (19) by the distance x' measured from the right end, and by interchanging a and b. Hence, to the right of the load we have the deflection

$$y' = \frac{Pax'}{6EIL}\left(b\ (L+a) - x'^2\right) \tag{20}$$

By substituting $x = a$ in (19) the deflection under the load is found to be

$$y_P = \frac{Pa^2b^2}{3EIL} \tag{21}$$

When P is in the right half of the beam then the location of the maximum deflection is found by differentiation of (19). Thereby the distance from the left end to the point of maximum deflection is found to be

$$x = \sqrt{(1/3)a(L+b)} \tag{22}$$

The point of maximum deflection could also be found, perhaps more directly, as the point of maximum moment in the conjugate beam, that is, as the point of zero shear in the conjugate beam.

E. *Simple beam loaded by couples at the ends of the span* (Fig. 14).—The slopes at the ends of the span have a particular interest. The moments M_A and M_B, which are applied at the ends as shown in Fig. 14, cause a trapezoidal M/EI-diagram. This M/EI-trapezoid may be considered as consisting of the two triangles which are marked *I* and *II*, and which have their centroids over the third-points of the span. Triangle *I* acting as a load on the conjugate beam is carried two-thirds by the left support and one-third by the right support; triangle *II*, in the same way, one-third by the left support, two-thirds by the right support. The shears in the conjugate beam, or the end slopes of the given beam, are then:

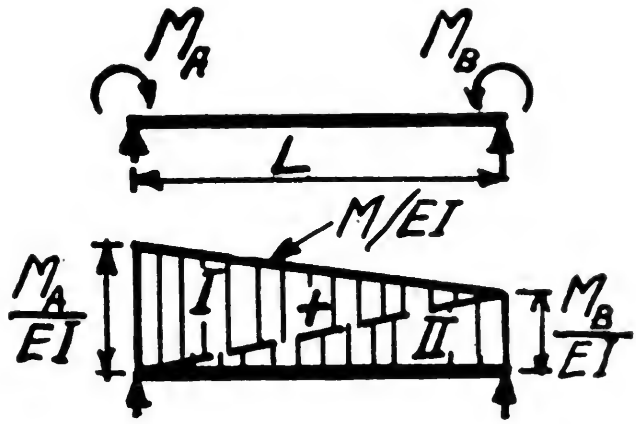

Fig. 14.

At the left end:

$$\theta_A = \frac{L}{6EI}\left(2M_A + M_B\right) \tag{23}$$

At the right end:

$$\theta_B = -\frac{L}{6EI}\left(M_A + 2M_B\right) \tag{24}$$

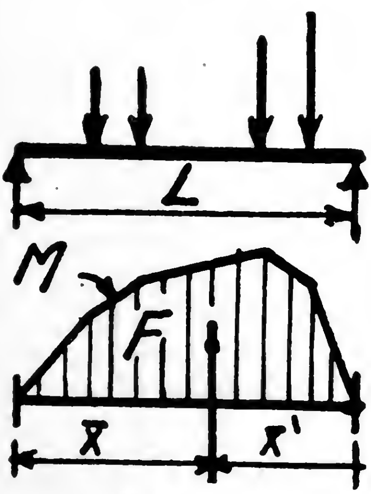

Fig. 15.

F. *Simple beam, any moment diagram.*—Let F be the area of the moment diagram (Fig. 15). Let the distance of its centroid from the left end be $\bar{x}$, from the right end $\bar{x}'$. Then the end slopes, found as end shears in the conjugate beam, are seen to be:

At the left end:

$$\theta_A = \frac{F\bar{x}'}{EIL} \tag{25}$$

At the right end:

$$\theta_B = -\frac{F\bar{x}}{EIL} \tag{26}$$

11. *Case in which the Cross Section of the Beam is not Constant.*—A single example will be sufficient in illustrating the use of the conjugate beam method in the

case of a varying cross section. We shall take the case of a simple beam carrying a concentrated load P at the center,—see Fig. 16. The moment of inertia is assumed to be I_0 on the middle half of the beam, $I_0/2$ on the outer quarters. The moment diagram is a triangle with altitude $PL/4$. Dividing the ordinates in the triangular moment diagram by EI_0 within the middle half of the span, and by $EI_0/2$ outside the middle half, we obtain the M/EI-diagram shown below in Fig. 16. This M/EI-load can be separated into the four triangles *I, II, III,* and *IV*. Combining the reactions and bending moments produced by the triangular loads *I* and *II* on the one hand, *III* and *IV* on the other hand, we find the following expressions for the end shear and central moment in the conjugate beam; that is, for the end slope and central deflection of the given beam:

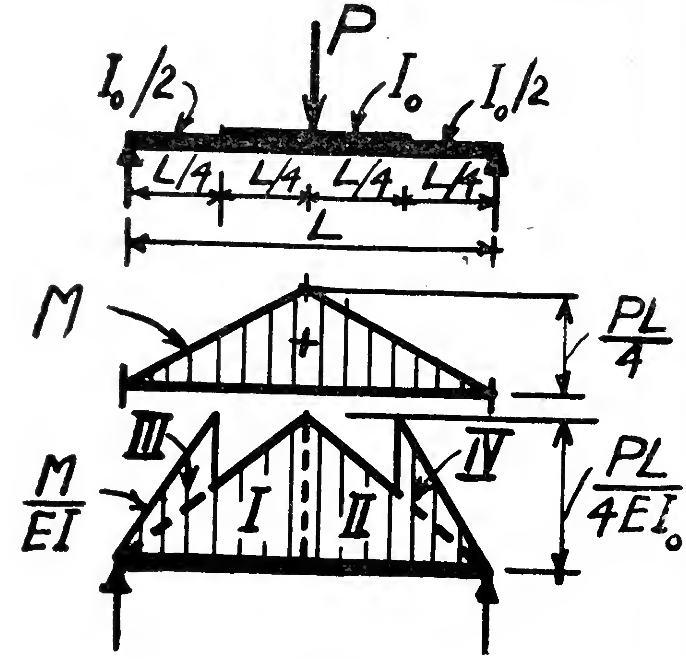

Fig. 16.

$$\theta_{max}=\frac{5\,PL^2}{64\,EI_0}\,, \qquad y_{max}=\frac{3\,PL^3}{128\,EI_0} \tag{27}$$

12. *Beam with Overhanging Ends.*—The conjugate beam corresponding to a beam with overhanging ends was indicated in Fig. 3*c*. As an example illustrating the application of the conjugate beam method to beams of this and similar types we shall take the case shown in Fig. 17. The load consists of two equal forces P at the free ends. The overhanging ends have the same length a. The conjugate beam is indicated below. The M/EI-diagram is a trapezoid with altitude Pa/EI. This diagram, acting as a load on the conjugate beam, causes at the center of the middle span the following moment, which is equal to the deflection of the given beam at the center:

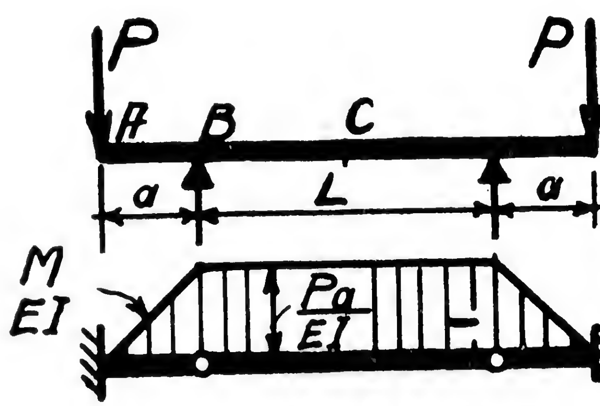

Fig. 17.

$$y_C=-\frac{PaL^2}{8EI} \tag{28}$$

At the left hinge the shear, equal to the slope over the left support in the given beam, is:

$$\theta_B=\frac{PaL}{2EI} \tag{29}$$

At the left end the shear in the conjugate beam, or the slope of the given beam, is one-half the M/EI-area, that is,

$$\theta_A = -\frac{Pa(L+a)}{2EI} \tag{30}$$

The deflection at the left end, found as the moment in the conjugate beam, is:

$$y_A = \frac{Pa^2 L}{2EI} + \frac{Pa^3}{3EI} \tag{31}$$

III. STATICALLY INDETERMINATE BEAMS.

13. *General Remarks.*—The following cases of statically indeterminate beams were shown in Fig. 4: a beam fixed at both ends; a beam fixed at one end, simply supported at the other; and a continuous beam. The general definition is recalled: beams are called statically indeterminate when, with given loads, it is not possible to determine the reactions, shears, and bending moments, without taking the deflections into consideration.

The problem involved may be separated into three parts. The first is to ascertain the character of the reactions, and of the shear and bending moment diagrams. The second is to determine the reactions and the moment diagrams quantitatively. The third is to find the slopes and the deflections. The first part is solved by comparing the given statically indeterminate beam with a "substitute beam" which is statically determinate, but which is made to deflect in the same way as the given beam by introducing certain supplementary loads at special points. The second part is solved conveniently by the conjugate beam method, by using such conjugate beams as were indicated in Fig. 4. Dimensions of the moment diagram are then determined by the condition that the conjugate beam must be in equilibrium. The third part can be solved by the conjugate beam method; when once the moment diagram of the given beam is known, then the slopes and deflections may be determined as shears and bending moments in the conjugate beam, just as when the given beam is statically determinate. Thus the conjugate beam method will serve the double purpose of determining not only the deflections and slopes, but also the moments, shears, and reactions.

The stiffness factor EI will again be assumed constant throughout the length of the beam, except when otherwise stated.

14. *Beams Fixed at Both Ends.*—Fig. 18*a* shows a single-spanned beam, fixed at both ends, and loaded in some general way. At each end there is a reaction consisting of a force which is numerically equal to the end shear, plus a couple, which is numerically equal to the bending moment at the end. The first step, according to the plan just outlined is to indicate the "substitute beam." The simple beam shown in Fig. 18*b* will be used. It has the same dimensions as the given beam. It carries the same loads throughout the length, except that at the ends the two couples $-M_A$ and $-M_B$ are applied as external loads, as are indicated in Fig. 18*b*. If it were not for the effect of these end couples, the deflections caused by downward loads would be decidedly greater in the substitute beam than in the given beam. We shall make the couples M_A and M_B equal to the bending moments at the ends of the given beam. The result is that when the reactions are considered as included in the sets of acting forces and couples, then the complete sets of forces and couples acting on the two beams are identical. It follows that the two beams

will have the same moment diagrams, and we may study the bending moments of the given beam by studying those of the substitute beam.

Fig. 18*c* shows what we shall call the "moment diagram of the simple span," that is, the moment diagram caused in the substitute beam by the given loads alone, when the end couples $-M_A$ and $-M_B$ are not acting. When the loads are all downward as in the figure, then these moments are all positive. In that case the end couples will have the directions indicated by the arrows in Fig. 18*b*. Such end

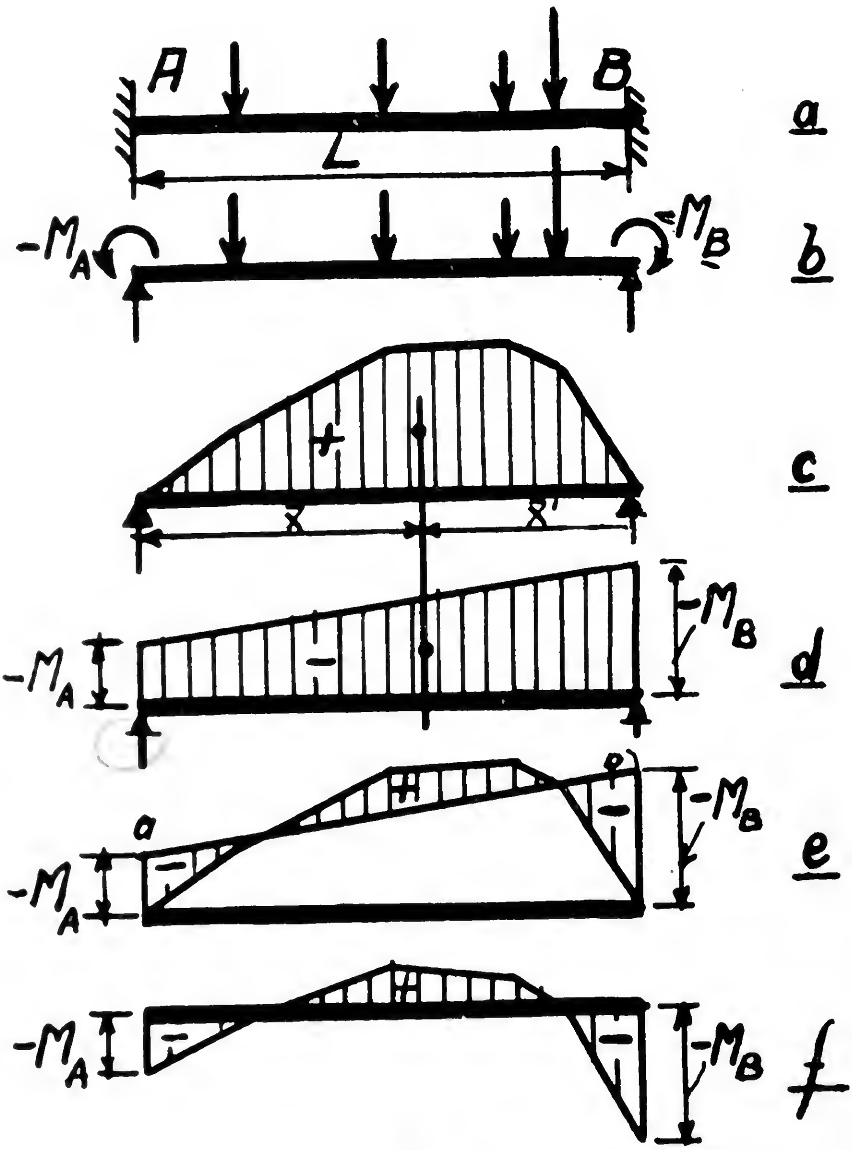

Fig. 18.

couples, acting alone, produce negative bending moments. The diagram of these moments is the trapezoid in Fig. 18*d*. By superimposing the "end moment trapezoid" *d* on the "simple span moment diagram" *c* the resultant moment diagram which is shown cross-hatched in Fig. 18*e* is obtained. In Fig. 18*f* the same diagram is shown, referred to a horizontal base.

We have now ascertained the character of the moment diagram, and we are ready for the second step in the analysis: to determine the yet unknown dimensions in the moment diagram, by using the conjugate beam method. That is, we shall determine the end moments M_A and M_B, or, in terms of graphics, complete the diagram in Fig. 18*e* by drawing the "closing line" *ab* in its correct position. The

conjugate beam corresponding to a fixed-ended beam was indicated in Fig. 4*a*. It is an unsupported beam. Its load diagram is found by dividing the ordinates of the moment diagrams in Fig. 18*e* or *f* by the constant factor EI. This M/EI-diagram, acting as a load, must hold the unsupported conjugate beam in equilibrium. Or, the M/EI-diagram must hold itself in equilibrium. As the M/EI-diagram and the moment diagram are similar, EI being constant, it follows that also the moment diagram, considered as acting as a load on a free beam, must hold itself in equilibrium. Or, the diagrams in Fig. 18*c* and *d* must hold one another in equilibrium. This condition is brought about when minus the area in Fig. 20*d* is equal to the area in Fig. 20*c*, and when in addition the two areas have their centroids on the same vertical line. *Or, the end moment trapezoid has an area equal to but opposite the moment area of the simple span, and the two areas have their centroids on the same vertical line**.

The following notation is used:

F = moment area of the simple span, that is area of the moment diagram which the given load would produce in the simple beam having the same span. (Fig. 18*c*).

$\bar{x}$ = horizontal distance of the centroid of the area F from the left end.

$\bar{x}'$ = horizontal distance of the centroid of F from the right end.

M_A = bending moment at the left end.

M_B = bending moment at the right end.

With this notation the condition that the two moment areas must be equal but opposite is expressed:

$$-(L/2)\ (M_A+M_B) = F \tag{32}$$

The condition that the two areas must have their centroids on a common vertical leads to the result that the moment of the trapezoid in Fig. 18*d* about the right end must be equal and opposite to the moment of the moment area of the simple span about the same point, or

$$-(L^2/6)\ (2M_A+M_B) = F\bar{x}' \tag{33}$$

Taking moments about the left end we find in the same way

$$-(L^2/6)\ (M_A+2M_B) = F\bar{x} \tag{34}$$

Any two of the equations (32), (33), and (34) determine the end moments M_A and M_B.

When the load is symmetrical, then the end-moment trapezoid becomes a rectangle, and each end moment becomes equal to minus the average ordinate of the simple span moment area, or

$$M_A = M_B = -F/L \tag{35}$$

Some of the important special cases will now be analyzed.

A. *Uniformly Distributed Load.* (Fig. 19).—The simple-span moment diagram is a parabola with maximum ordinate $M_0 = (1/8)wL^2$, and with total area $(2/3)\ M_0L$. Hence, by (35)

$$M_A = M_B = -(2/3)M_0 = -(1/12)wL^2 \tag{36}$$

*This theorem is stated by Maurice Levy in his Statique in Graphique. v. 2, 1886, p. 109.

The positive moment at the center is then

$$M_C = (1/3)M_0 = (1/24)wL^2 \tag{37}$$

It should be noted that these formulas apply only when the ends are absolutely rigidly fixed. Actual end conditions rarely furnish more than partial rigidity; hence the coefficient *1/24* in (37) must be used only with great caution, and in most practical problems it should be replaced by some higher value, such as *1/12*.

We shall use the case to illustrate how the third step in the complete analysis may pe performed: namely, the determination of the deflections. Two solutions will be indicated, in both of which the conjugate beam method will be used. In the first solution the deflections of the given beam are found directly as bending moments in the unsupported conjugate beam. The M/EI-load is shown below in Fig. 19.

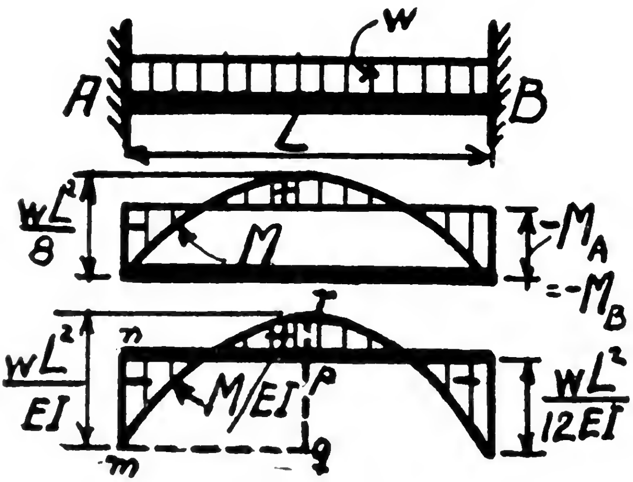

Fig. 19.

Assume that the object is to find the maximum deflection of the given beam. It occurs at the center and is equal to the bending moment in the conjugate beam at that point. The M/EI-load to the left of the center may be considered as consisting of two parts: the rectangle *mnpq* acting as an upward load, combined with the parabolic area *mrq* acting as a downward load. These two areas have the same size, $wL^3/(24EI)$. Their centroids are at the horizontal distances $L/4$ and $5L/16$, respectively, from the left end; that is, their mutual horizontal distance is $L/16$. The couple formed by these two loads is equal to the moment in the conjugate beam at the center, that is, equal to the deflection y_{max} of the given beam at the center. This gives the computation:

$$y_{max} = \frac{wL^3}{24EI} \cdot \frac{L}{16} = \frac{wL^4}{384EI} \tag{38}$$

This deflection is seen to be only one-fifth of that found for the corresponding simple beam,—see formula (17).

The other method of determining the deflections is based on the principle that the substitute beam (see Fig. 18*b*) is made to deflect in the same way as the given beam. Since the substitute beam is a simple beam, its conjugate beam is a simple beam. Thus we may use a simple beam as a "substitute conjugate beam." This procedure has the advantage that it allows us to separate the M/EI-load into two parts, each of which, acting alone, would not hold the unsupported conjugate beam in equilibrium. As the one part we take the parabolic M/EI-area corresponding to the simple span, as the other the rectangle corresponding to the end moments alone. The moment at the center due to the simple-span parabolic area was found previously. It is the simple-span deflection derived in formula (17), equal to $(5/384EI)wL^4$. The rectangular diagram caused by the end moments has an altitude $(-1/12EI)wL^2$. It represents a uniformly distributed load, and gives therefore a moment at the center equal to $-(1/8)\ (1/12EI)wL^4$. Superposition of the two moments gives the following computation of the resultant moment at the center, equal to the deflection of the given beam,

$$y_{max} = \left(\frac{5}{384} - \frac{1}{8} \cdot \frac{1}{12}\right)\frac{wL^4}{EI} = \frac{wL^4}{384EI}$$

which is the result expressed in formula (38).

B. *Concentrated Load at Center* (Fig. 20.).—The simple-span moment diagram is a triangle, with altitude $(1/4)PL$. The average ordinate is one-half the altitude; hence the end moments are

$$M_A = M_B = -(1/8)PL, \quad (39)$$

and the moment at the center is

$$M_C = +(1/8)PL \quad (40)$$

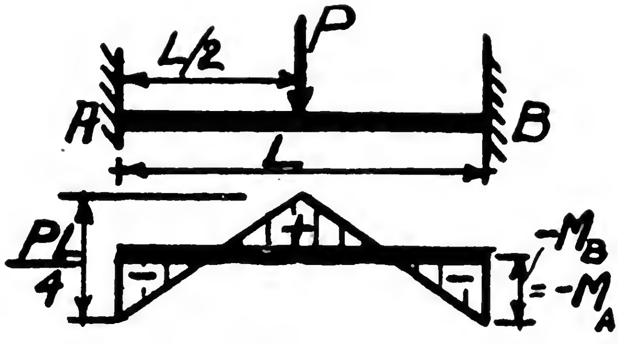

Fig. 20.

In the same way as in the preceding case, by the use, for example, of the second scheme of computation, the central deflection is expressed:

$$y_{max} = \left(\frac{1}{48} - \frac{1}{8} \cdot \frac{1}{8}\right)\frac{PL^3}{EI} = \frac{PL^3}{192EI} \quad (41)$$

C. *Concentrated Load at Any Point* (Fig. 21).—The load P is at the distances a from the left end, b from the right end. The simple-span moment diagram is a triangle with altitude Pab/L, area $F = Pab/2$, and with the center of gravity distances $\overline{x} = (L+a)/3$ from the left end, and $\overline{x}' = (L+b)/3$ from the right end. By substituting these values in the general equations (33) and (34) these equations become

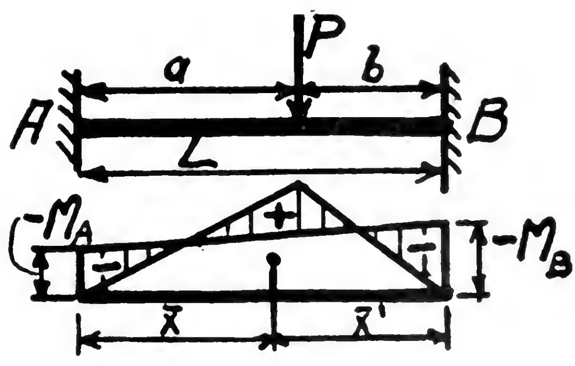

Fig. 21.

$$-(L^2/6)\ (2M_A + M_B) = (Pab/2) \cdot (L+b)/3$$

$$-(L^2/6)\ (M_A + 2M_B) = (Pab/2) \cdot (L+a)/3$$

Solving these equations we find

$$M_A = -Pab^2/L^2 \quad ; \quad M_B = -Pa^2b/L^2 \quad (42)$$

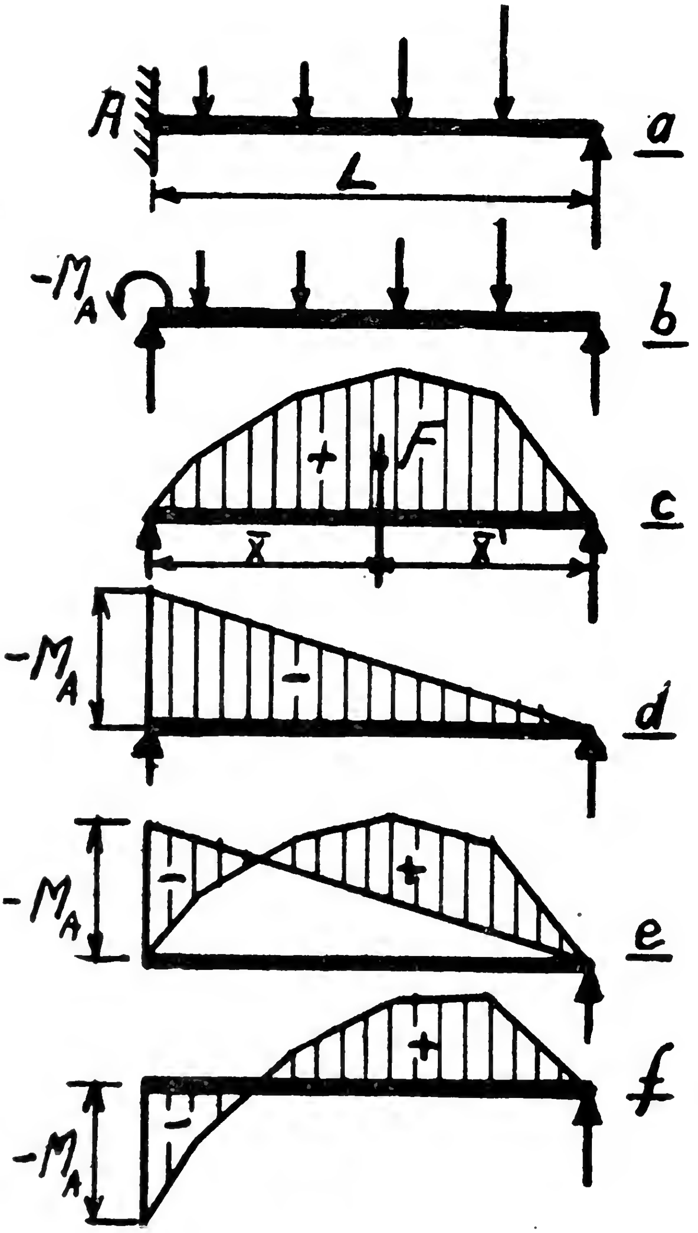

Fig. 22.

15. *Beams Fixed at One End, Simply Supported at the Other End.*—The beam in Fig. 22*a* is fixed at the left end *A*, simply supported at the right end. Its load is of a general type. In analyzing this case a procedure may be followed which is quite similar to that of the preceding case. The simple beam in Fig. 22*b* is introduced as a substitute beam. The load applied is that of the given beam plus an end couple $-M_A$ acting as shown and equal to the couple-component of the reaction of the given beam at *A*. The result is that the two beams will act alike. The moment diagram of either beam can therefore be found by superposition of the following two component parts, derived by consideration of the substitute beam: the simple-span moment area shown in Fig. 22*c*; and the end moment diagram, here a triangle, shown in Fig. 22*d*. The resultant diagram is shown crosshatched in Fig. 22*e*. The resultant moments are measured there from the inclined closing line. The same diagram, referred to a horizontal base, is shown in Fig. 22*f*.

A conjugate beam representing this case was indicated in Fig. 4*b*: it is free at the left end, simply supported at the right end. It is incompletely supported, but it will be in equilibrium if the moment of the M/EI-diagram about the right end is zero. As EI is constant, this condition will be satisfied when the moment diagram itself considered as a load has a zero moment about the right end. We denote again: F=simple span moment area $\bar{x}$ and $\bar{x}'$ = center of gravity distances (see Fig. 22*c*). By combining the moments of the two component parts of the moment area (Fig. 22 *c* and *d*) the condition is found

$$F\bar{x}' - \frac{L(-M_A)}{2} \cdot \frac{2L}{3} = 0$$

or

$$M_A = -3F\bar{x}'/L^2 \tag{43}$$

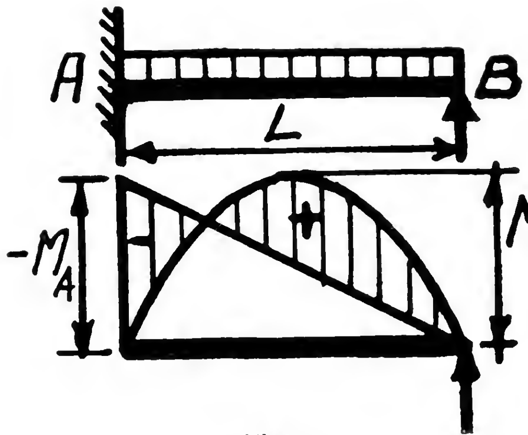

Fig. 23.

This formula is the same as (33) with $M_B = O$.

Two definite cases will now be analyzed.

A. *Uniformly Distributed Load w.* (Fig. 23).—The maximum simple-span moment is $M_0 = (1/8)wL^2$. Substituting in (43) $F = (2/3)ML_0$ $\overline{x'} = L/2$ we find for the end moment

$$M_A = -M_0 = -(1/8)wL^2 \tag{44}$$

The reaction, for example, at the fixed end, may be found as follows: It is equal to the end shear, which is equal to the end slope in the resultant moment diagram. This slope is found by combining the slope of the closing line with the end slope in the simple-span moment diagram. The latter is the same as the end shear in the simple span, or $wL/2$. The slope of the closing line is numerically $wL/8$. A consideration of the diagram in Fig. 23 shows that the slopes must be combined by adding their numerical values. Hence the values of the two reactions are

$$A = (5/8)wL \quad , \quad B = (3/8)wL \tag{45}$$

It follows that the point of the given beam where the shear is zero, is at the distance $(3/8)L$ from the right end. The maximum positive moment occurs at that point and is found to be

$$M_{max} = +(9/128)wL^2 \tag{46}$$

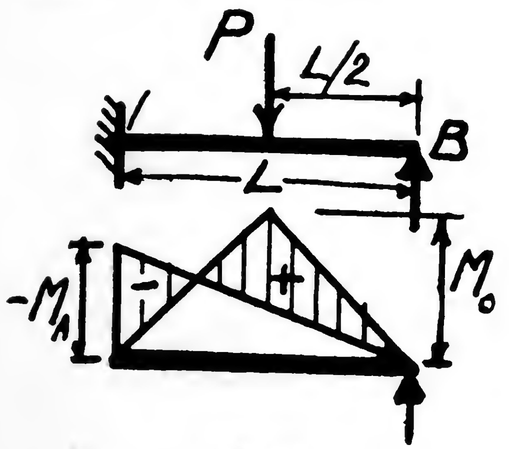

Fig. 24.

B. *Concentrated Load at Center.* (Fig. 24).—The maximum simple-span moment is $M_0 = (1/4)PL$. Substituting in (43) $F = (1/2)M_0L$, $\overline{x'} = L/2$ we find the end moment

$$M_A = -(3/4)M_0 = -(3/16)PL \tag{47}$$

Then, from the shape of the diagram the maximum positive moment, occurring under the load, is found to be

$$M_P = (5/8)M_0 = (5/32)PL \tag{48}$$

As in the preceding case the reactions may be found by adding $\pm M_A/L$ to the simple span reactions. The values are then found:

$$A = (11/16)P \quad , \quad B = (5/16)P \tag{49}$$

16. *Continuous Beams with Constant Cross Section and with Supports on the Same Level.*—Fig. 25*a* shows two consecutive spans of a continuous beam loaded in some general way. *EI* is constant. The supports are simple supports. The supports and spans are numbered from the left end, and in that way the two spans shown are the *nth* and $(n+1)th$. The beam system in Fig. 25*b* is introduced as "substitute beam." It differs from the given beam by having hinges over the supports but otherwise it has the same dimensions as the given beam. It carries the same loads as the given beam, but in addition, each span is loaded by end couples, such as the couples $-M_{n-1}$, $-M_n$, and $-M_{n+1}$ which are indicated in Fig. 25*b*. By choosing M_{n-1}, M_n, and M_{n+1} equal to the bending moments in the given beam over the corresponding supports the substitute beam is made to act like the given beam, and the two beams will then have identical deflections, bending moments, etc.

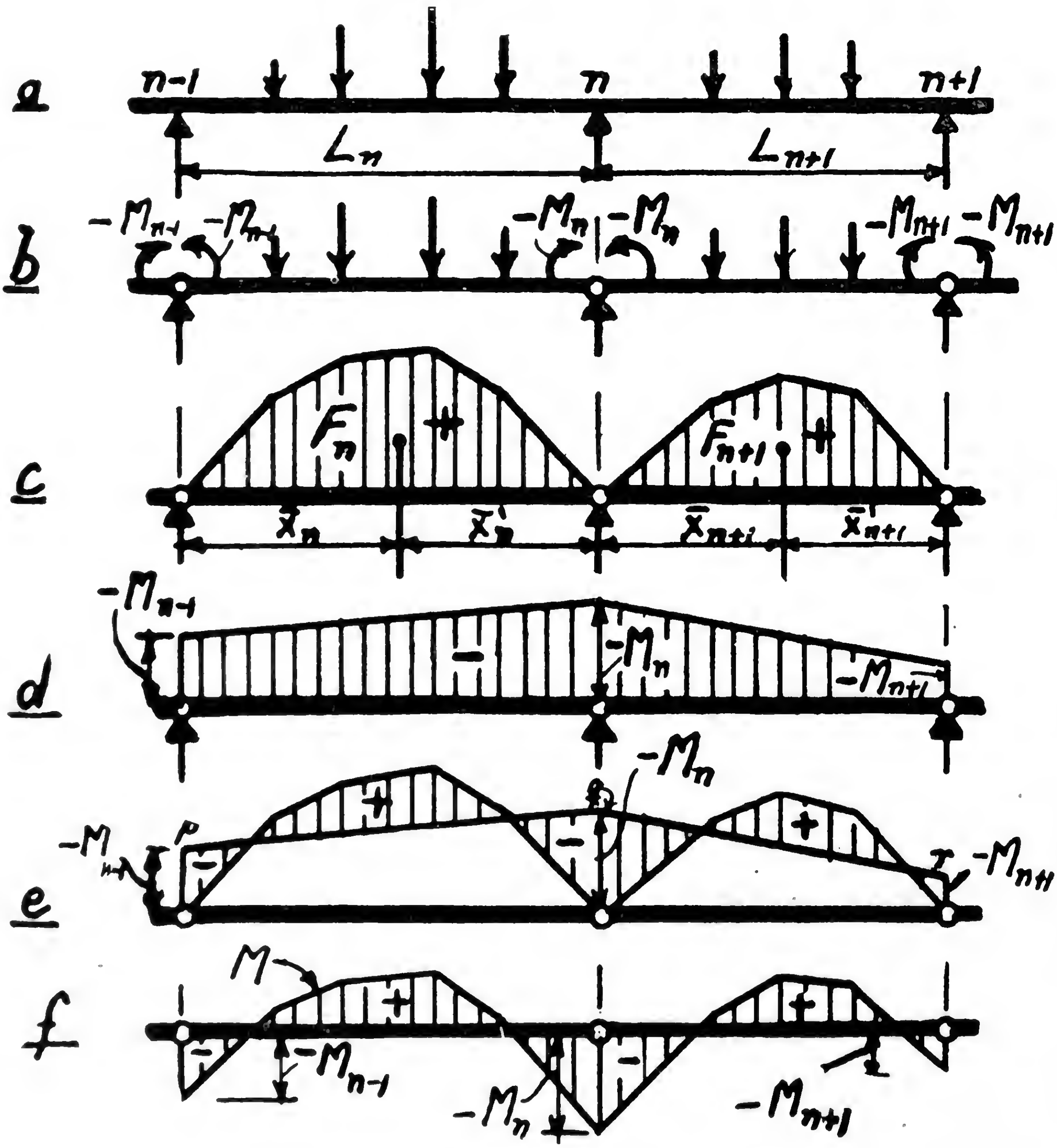

Fig. 25.

In the same way as in the preceding cases of statically indeterminate beams the resultant moment diagram may be found by superimposing two separate diagrams: The one consists of the simple span moment diagram shown in Fig. 25*c*, that is, the mo-

ment diagrams in the substitute beam caused by the original given loads only, without the influence of the end couples. The other is the diagram in Fig. 25*d*, which is produced in the substitute beam by the end moments alone. It consists of a series of trapezoids, of which the upper sides are connected into a polygon. The resultant diagram is the cross-hatched area in Fig. 25*e*. Fig. 25*f* shows this diagram referred to a horizontal base. In accordance with the usage which was introduced in the preceding cases of statically indeterminate beams, the polygon *pqr* in Fig. 25*d* is called the closing line.

The nature of the conjugate beam was indicated in Fig. 4*c*. At the supports over which there is continuity the conjugate beam has an unsupported hinge. This conjugate beam is "incompletely supported." But it will be in equilibrium provided the M/EI-load satisfies certain special conditions, which may be stated as follows: We replace the conjugate beam temporarily by a "substitute conjugate beam" of the folowing description: it carries the same M/EI-load as the original conjugate beam, and it has the same hinges; the only difference is that simple supports are brought up under the hinges which were unsupported in the original conjugate beam. Assume now that the M/EI-load causes the reactions from all such supports to be zero. In that case the substitute conjugate beam, with supported hinges, and the original conjugate beam, with unsupported hinges, will act alike. That is, an M/EI-load adjusted in such a way will hold the original conjugate beam in equilibrium. The substitute conjugate beam is in fact a series of simple beams. It may be interpreted as the conjugate beam corresponding to the substitute beam in Fig. 25*b*.

EI was assumed constant. Hence, without disturbing the equilibrium, the M/EI-diagram can be replaced by the moment diagram itself, acting as a load. This consideration leads to the following law, which is the equivalent of the original conditions: the moment diagram acting as a load on the substitute conjugate beam must cause the reactions of its intermediate supports to be zero. This law will now be expressed in terms of equations. The notation is:

L_n = length of the *nth* span.
F_n = area of the simple-span moment diagram in the *nth* span (Fig. 27*c*).
$\bar{x}_n$ = horizontal distance of the centroid of F_n from the left end of the *nth* span.
$\bar{x}'_n$ = horizontal distance of same point from the right end of the span.
M_n = moment in given beam over the *nth* support.
Indices $n + 1$ and $n - 1$ are used in the same way as n.

We shall especially consider the middle support in Fig. 25*e*. Its reaction may be expressed as the sum of the reactions due to the separate loads in Fig. 25*d* and *c*. The diagram in Fig. 25*d*, acting alone as a load, would give the reaction

$$(L_n/6)\,(M_{n-1}+2M_n) + (L_{n+1}/6)\,(2M_n+M_{n+1}) \qquad (50)$$

In a similar way the reaction due to the moment diagram of the simple span in Fig. 25*c* is found to be

$$F_n\bar{x}_n/L_n + F_{n+1}\,\bar{x}'_{n+1}/L_{n+1} \qquad (51)$$

By putting the one of these reactions equal to but opposite the other the following equation is found:

$$-M_{n-1}L_n - 2M_n(L_n+L_{n+1}) - M_{n+1}L_{n+1} = 6F_n\bar{x}_n/L_n + 6F_{n+1}\bar{x}'_{n+1}/L_{n+1} \quad (52)$$

This equation gives a relation between the moments over three consecutive supports. It is known as the *theorem of three moments*. By writing one such equation for

each support over which the beam is continuous, a number of equations is found, equal to the number of unknown moments over such supports. The theorem of three moments represents, therefore, a solution of the problem of continuous beams over simple supports.

The reaction of the given beam, for example, at the middle support in Fig. 25, may be found as the increase of shear when passing from the left to the right of the support. This increase is the same as the increase of slope in the moment diagram *f* when passing the same point. It may be found as the sum of the corresponding increases in the diagrams *c* and *d*. The increase of slope at the middle support in *c* is the same as the simple-span reaction, that is, the reaction produced in the substitute beam in Fig. 25*b* when the given load acts alone without the end couples shown in that figure. To this reaction we add the increase of slope at the middle support in the diagram *d*. Since the ordinates of the diagram in Fig. 25*d* are negative, this increase is positive in the particular case in Fig. 25, and the effect of the continuity is an increase of the middle reaction. In any case this increase may be expressed as

$$\frac{M_{n+1}-M_n}{L_{n+1}} - \frac{M_n-M_{n-1}}{L_n} \qquad (53)$$

Some particular cases will now be treated.

A. *Uniformly Distributed Loads.*—We assume the following uniformly distributed loads:

w_n = load per unit length in span n, constant throughout the length of the span,

w_{n+1} = same in span $n+1$.

In that case we have: $F_n = (2/3)\ (1/8)\ wL^3 = (1/12)wL^3$ and $\bar{x}_n = L_n/2$, and similar expressions for span $n+1$. By substitution of these values the equation of three moments, (52), becomes

$$-M_{n-1}L_n - 2M_n(L_n+L_{n+1}) - M_{n+1}L_{n+1} = (1/4)w_nL_n^3 + (1/4)w_{n+1}L^3_{n+1} \qquad (54)$$

When the spans are equal, $L_n = L_{n+1} = L$, this equation becomes

$$-M_{n+1} - 4M_n - M_{n+1} = (1/4)\ (w_n + w_{n+1})L^2 \qquad (55)$$

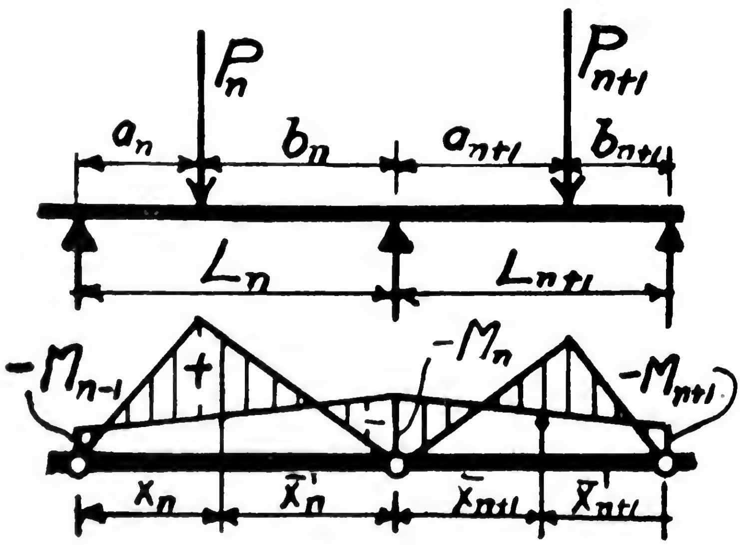

Fig. 26.

The equation (54) was derived by *Bertot* in 1855 and was also indicated by *Clapeyron* in 1857.* The general form (52) was derived by *Bresse.*** The three moment equation, whether in the general or special form, is often called *Clapeyron's equation.*

B. *One Concentrated Force in Each Span.*—Fig. 26 illustrates the case and gives the notation. The simple span moment area for each span is a triangle, with

dimensions defined as in Fig. 13. The following values are found:

$$F_n=(1/2)P_n a_n b_n \quad ; \quad \bar{x}_n=(1/3)(L_n+a_n) \quad ;$$
$$F_{n+1}=(1/2)P_{n+1}a_{n+1}b_{n+1} \quad ; \quad \bar{x}'_{n+1}=(1/3)(L_{n+1}+b_{n+1})$$

Substitution of these values in the general equation (52) gives the three moment equation

$$-M_{n-1}L_n-2M_n(L_n+L_{n+1})-M_{n+1}L_{n+1}=$$
$$\frac{P_n a_n b_n(L_n+a_n)}{L_n}+\frac{P_{n+1}a_{n+1}b_{n+1}(L_{n+1}+b_{n+1})}{L_{n+1}} \tag{56}$$

C. *Each Span Carries a Uniform Load and, in Addition, Several Concentrated Forces.*—This case is solved by superposition of solutions of equations (54) and (56). By adding the right side expressions the following resultant three-moment equation is found

$$-M_{n-1}L_n-2M_n\,(L_n+L_{n+1})-M_{n+1}\,L_{n+1}$$
$$=\frac{w_nL_n^3}{4}+\frac{w_{n+1}L^3_{n+1}}{4}+\frac{\Sigma P_n a_n b_n\;(L_n+a_n)}{L_n}+\frac{\Sigma\, P_{n+1}a_{n+1}b_{n+1}(L_{n+1}+b_{n+1})}{L_{n+1}} \tag{57}$$

This three-moment equation is of a rather general form. The summations on the right side may easily be replaced by integrals.

17. *Continuous Beams Having Different Cross-Sections in Different Spans, But With the Supports at the Same Level.*—It is assumed that the cross-section is constant throughout each span, but that it may vary from one span to another. We denote:

I_n = moment of inertia of cross-section in *nth* span.
I_{n+1} = same in $(n+1)$*th* span.

The same procedure may be followed as when the cross-section is constant, except that in the present case the M/EI-load can not be replaced by the moment diagram itself as a load on the conjugate beam. A solution is found by transforming the expressions (50) and (51), which represent the reactions due to M-loads, as follows: the parts of these reactions caused by the loads on the *nth* span are divided by EI_n, while the parts caused by the loads on the $(n+1)$*th* span are divided by EI_{n+1}. Thereby (50) and (51) are changed into the following expressions representing reactions at the middle support in Fig. 25*e*:

$$(L_n/6EI_n)\;(M_{n-1}+2M_n)\;+\;(L_{n+1}/6EI_{n+1})\;(2M_n+M_{n+1}) \tag{58}$$

and

$$F_n\bar{x}_n/EI_nL_n\;+\;F_{n+1}\bar{x}'_{n+1}/EI_{n+1}L_{n+1} \tag{59}$$

Expressing these two reactions as equal and opposite we find the three-moment equation

$$-M_{n-1}L_n/I_n-2M_n\;(L_n/I_n+L_{n+1}/I_{n+1})\;-$$
$$M_{n+1}L_{n+1}/I_{n+1}=\frac{6F_n\bar{x}_n}{I_nL_n}+\frac{6F_{n+1}\bar{x}'_{n+1}}{I_{n+1}L_{n+1}} \tag{60}$$

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*Bertot, Comptes Rendus de la Societé des Ingénieurs Civils, 1855, p. 278. Clapeyron, Comptes Rendus, v. 45, 1857, p. 1876.

**According to A. Ostenfeld, Teknisk Elasticitetslære, 3 ed. 1916, p. 216.

Equation (60) includes (52) as a special case: namely, that in which $I_n = I_{n+1}$. When the load on the two spans consists of the uniformly distributed loads w_n and w_{n+1}, then (60) takes the following special form, which corresponds to (54), and includes (54) as a special case:

$$-M_{n-1}L_n/I_n - 2M_n\,(L_n/I_n + L_{n+1}/I_{n+1}) - M_{n+1}L_{n+1}/I_{n+1} = \frac{w_n L^3_n}{4I_n} + \frac{w_{n+1}L^3_{n+1}}{4I_{n+1}} \qquad (61)$$

18. *Continuous Beams with Supports Out of Level.*—The case is represented in Fig. 27*a* where three consecutive supports are shown with the deflections y_{n-1}, y_n, and y_{n+1}. Such movements of the supports out of level would cause stresses in the continuous beam even if no vertical loads were carried. We shall assume that the deflections y_{n-1}, y_n, and y_{n+1} are definite quantities which are known beforehand.

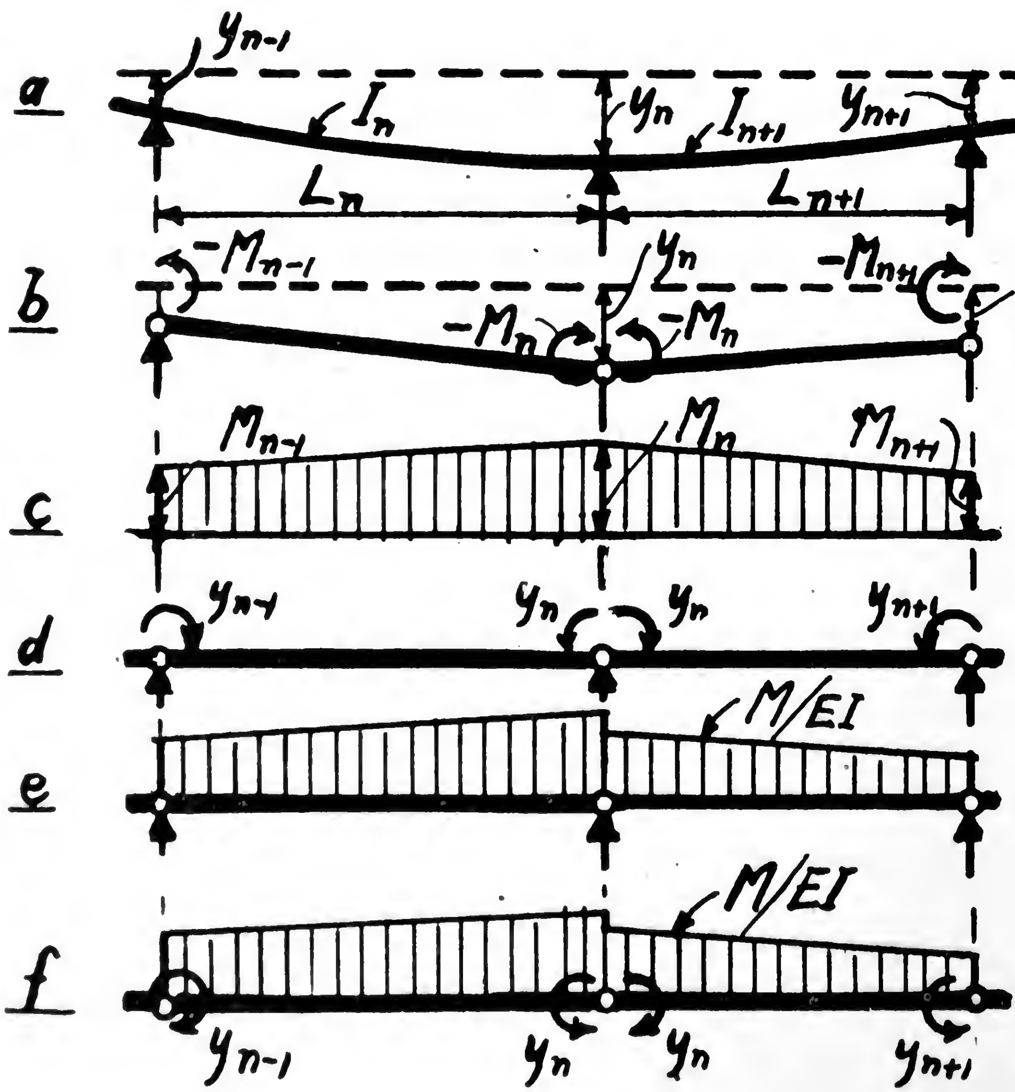

Fig. 27.

Fig. 27*b* shows a substitute beam which has the following properties: its supports are displaced as those of the given beam; it has hinges over the supports; each span is loaded by end couples, such as $-M_{n-1}$, $-M_n$, etc., where M_n= bending moment in the original beam over the *nth* support; in other respects the two beams are alike. Under these circumstances the beams *a* and *b* will deflect alike, and the bending moments in both beams will be of the types shown in Fig. 27*c*.

The conjugate beam with its loads is shown in Fig. 27*f*. The M/EI-load corresponds to the moment diagram in Fig. 27*c*. The conjugate beam has unsupported hinges. Right at these hinges there must be bending moments equal to the deflections y_{n-1}, y_n, and y_{n+1} in Fig. 27*a*. These bending moments must therefore be transferred to the beam by pairs of external couples acting at the hinges as indicated by the arrows in Fig. 27*f*. These loads must hold the conjugate beam in equilibrium. Fig. 27*d* and *e* show the end couples and the distributed M/EI-load separately, acting on a substitute beam which has simply supported hinges. The middle reaction in *d* is

$$\frac{y_{n-1}-y_n}{L_n}+\frac{y_{n+1}-y_n}{L_{n+1}} \tag{62}$$

The reaction in Fig. 27*e* is the same as that already indicated by expression (58). By expressing the reactions in *d* and *e* as equal but opposite we find the following three-moment equation, which represents the effect of the supports being out of level:

$$\begin{aligned}-M_{n-1}L_n/I_n-2M_n\,(L_n/I_n+L_{n+1}/I_{n+1})\,-\\ M_{n+1}L_{n+1}/I_{n+1}=6E\left(\frac{y_{n-1}-y_n}{L_n}+\frac{y_{n+1}-y_n}{L_{n+1}}\right)\end{aligned} \tag{63}$$

The right side in this equation may be simplified by a particular choice of the line from which the deflections are measured. In Fig. 28, AB is the original undeflected center line. But we shall now measure the deflections from the chord CD. Then if we write $y_{n-1}=y_{n+1}=0$, $y_n=\delta_n$, the right side in (63) becomes

$$-6E\delta_n\,(1/L_n+1/L_{n+1}) \tag{64}$$

Substituting this expression in (63), and combining with the effect of vertical loads, as expressed by equation (60), we find the following general equation of three moments:

$$\begin{aligned}&-M_{n-1}L_n/I_n-2M_n\,(L_n/I_n+L_{n+1}/I_{n+1})-M_{n+1}L_{n+1}/I_{n+1}\\ &=\frac{6F_n\overline{x}_n}{I_nL_n}+\frac{6F_{n+1}\overline{x}'_{n+1}}{I_{n+1}L_{n+1}}-6E\delta_n\left(\frac{1}{L_n}+\frac{1}{L_{n+1}}\right)\end{aligned} \tag{65}$$

This equation takes into account both the ordinary bending effects, expressed by the moment areas F_n and F_{n+1}, and the out-of-level effect, defined by the distance δ_n in Fig. 28.

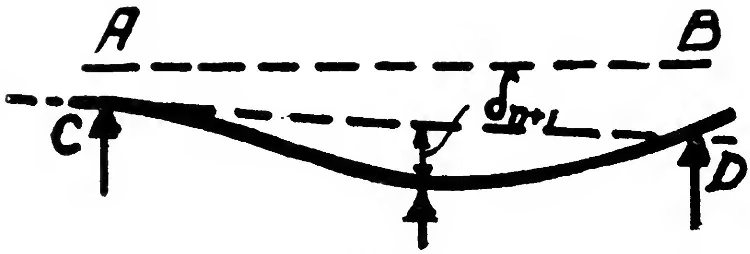

Fig. 28.

When the cross-section is constant throughout the length of the two spans, as expressed by $I_n = I_{n+1} = I$, then equation (65) takes the form:

$$-M_{n-1}L_n - 2M_n\,(L_n+L_{n+1}) - M_{n+1}L_{n+1}$$
$$= \frac{6F_n\overline{x}_n}{L_n} + \frac{6F_{n+1}\overline{x}'_{n+1}}{L_{n+1}} - 6EI\delta_n\left(\frac{1}{L_n}+\frac{1}{L_{n+1}}\right) \quad (66)$$

This is the general three-moment equation in case of constant cross-section.

WILLIAM HAMILTON RONEY

William Hamilton Roney, M. W. S. E., died Oct. 16, at his home in Alhambra, California, after a long illness, following paralysis in 1914, from which he never recovered sufficiently to engage in further work.

Mr. Roney was born in Warren County, Illinois, Jan. 10, 1857 and moved with his parents to Dayton, Ohio, in 1863. He began as bookkeeper and draftsman for Wuichet & Company, Sheet Metal Works, about 1881, and taught in the night drawing school of Dayton for about eight years. He worked for the Columbia Bridge Company of Dayton, first as draftsman, then as sales engineer from 1885 to 1889. He was engaged as engineer by Lane Bridge & Iron Works of Chicago in 1889 and while in this capacity contracted for and supervised the placing of the structural steel and fireproofing in the Utah Territorial Insane Asylum at Provo in 1890. He designed and supervised the construction of the first six steel highway bridges in Utah and the head gates and stop gates for the Bear River irrigating project, the largest project of its kind in the west at that date, during the years 1890-92. In 1893, he designed, contracted and supervised the building of the steel dome for Saltair Beach Pavilion on the South East shore of Great Salt Lake. He then returned to Chicago and as manager of the shop of the Lane Bridge and Iron Works for about two years dismantled the shop and moved and installed the machinery in the shop of the Wabash Bridge Company. In 1897 he started the preliminary tests and development of reinforced hollow tile construction for Mr. E. V. Johnson at Chicago. In 1898 he was experimental engineer for John S. Metcalf & Company of Chicago, James L. Record of Minneapolis and E. V. Johnson of Chicago, on fire proof construction for grain elevators. In March, 1898 he became the structural engineer for James L. Record of Minneapolis and designed the structural steel for a 2,000,000 bushel semi-fire proof grain elevator to be erected for the Pennsylvania Railway Terminal at Charlestown, Mass. This structure was probably the first attempt to depart from wood construction for grain elevators. He followed the fabrication through the shops of the Carnegie Steel Company, and supervised its erection. In 1899 he began business as engineer and contractor. Among some of the works he built as contractor were the first group of buildings for the University of Utah, located at Salt Lake City, the Ornamental Bronze Work for the Capitol Building at Denver, Colorado, the bear trap dams, canal lock gates and operating machinery for the Sanitary District of Chicago, located between Lockport and Joliet, Illinois, and the High and Manual Training School for Fort Wayne, Indiana. He also acted as consulting engineer for the National Fireproofing Company, planned their first testing laboratory at Chicago, and made some initial tests. In 1912 he wrote the "Collation of Tests of the Resisting Qualities of Terra Cotta Structural and Fire Proof Material," published by the National Fireprofing Company.

Mr. Roney is survived by his widow and one son, Wm. H. Roney, Jr., Associate W. S. E., and by a large circle of friends who appreciated his ability and his accomplishments.

NEW MEMBERS

At the meeting of the Board of Direction held October 17, the following were elected to membership in the Western Society of Engineers:

18	Frederick W. Greve, West Lafayette, Ind. (Transfer)	Member
44	Lester C. Bush, 34 Douglas St., San Francisco. (Transfer)	Associate
45	William H. Roney, Jr., 119 Third Ave., Alhambra, Cal. (Transfer)	Member
46	Frank Wolf, 3631 N. Hermitage Ave., Chicago	Associate
47	Karl M. Whitehead, Lewiston, Ill.	Junior
48	Emil Dasing, 1929 Warner Ave., Chicago. (Transfer)	Junior
49	James E. Sellers, Box 1006, Phoenix, Ariz. (Transfer)	Member
50	Loren L. Whitney, 1002 Hyslop Pl., Hammond, Ind.	Member
51	John Foster Kendrick, 413 Peoples Gas Bldg., Chicago	Associate
52	Eugene E. Altman, 7350 Luella Ave., Chicago. (Transfer)	Associate
53	Max A. Berns, 210 S. LaSalle St., Chicago	Member
54	Harvey Mitchell Anthony, Muncie, Ind.	Member
55	Roland C. Rehm, 1001 Otis Bldg., Chicago	Member
56	Herman Ritow, 4304 Oakenwald Ave., Chicago	Member
57	Julius A. Folse, 5363 W. End Blvd., New Orleans, La. (Transfer)	Associate
58	Dale Bumstead, Jr., 504 N. East Ave., Oak Park, Ill.	Junior
59	Chas. E. DeLeuw, 1206 Conway Bldg., Chicago. (Transfer)	Member
60	Ross W. McKinstry, 1012 Kimball Bldg., Chicago	Junior
62	Chas. Clarahan, Jr., 336 Gazette Bldg., Little Rock, Ark. (Transfer)	Associate

The following applications were received:

70	Carl August Wittlinger	Care of Klauer Mfg. Co., Dubuque, Iowa
71	Otto Wundrack	815 N. 5th Ave., Maywood, Ill.
72	H. I. Hettinger	879 Stephenson St., Freeport, Ill.
73	J. C. Sanderson	2705 Hartzell St., Evanston, Ill.
74	Henry A. Auerbach	6751 Cornell Ave., Chicago, Ill.
75	Elmer B. Mason	609 E. 22nd St., Chicago, Ill.
76	Lewis K. Sillcox	Box 579, Herrick Rd., Riverside, Ill.
77	Frank A. Randall	19 S. LaSalle St., Chicago, Ill.
78	Harold W. Munday	5658 Ridge Ave., Chicago, Ill.
79	Edwin M. Goodman	1719 Ridge Ave., Evanston, Ill.
80	Earl G. Millison	2802 Washington Blvd., Chicago, Ill.

POSITIONS WANTED

B-1150: DESIGNER OF AUTOMATIC MAchinery, experience in piano machinery, button machinery, paper-box machinery, machine tools and special machines.

B-1149: BRIDGE DESIGNER, STRUCTURAL designer, checker, experience with Mead-Morrison, Am. Bridge Co., C., M. & St. P. R. R. and Sanitary District; writer of specifications and contracts.

B-1148: TECHNICAL HIGH SCHOOL GRADuate, one year experience as assistant to Consulting Engineer making traffic survey of Chicago Surface Lines.

B-1147: REINFORCED CONCRETE AND structural designer, University of Ill., Arch. engineering, 1915; speaks German, French and Spanish.

B-1146: ARCHITECTURAL DRAFTSMAN, squad leader, checker, designer or estimator, experience Illinois Steel Company, and consulting engineer in heating and ventilating and architectural work.

B-1145: STRUCTURAL DRAFTSMAN AND detailer, student M. W. S. E., Armour Institute.

B-1144: DESIGNER OF CONVEYINIG MAchinery, 5½ years' experience.

B-1143: CIVIL ENGINEER, 15 YEARS' EXperience, R. R. location, construction, valuation of buildings and structures, industrial, appraisal, sewerage, paving, concrete highways, good executive; can handle labor. Experience as superintendent and foreman.

B-1142: GRADUATE LEWIS INSTITUTE 1915, special course in reinforced concrete, appraiser, architectural draftsman, 3½ years' railroad work, 1½ years with Sinclair Refining Co.

B-1142-A: GRADUATE HARRISON TECHNIcal High School, summer vacation, experience as production clerk and shop apprentice.

B-1141: STRUCTURAL DESIGNER, BRIDGE construction, building construction or appraisal work; four-year course C. E., University of Michigan, 1921.

B-1140: GRADUATED, C. E., UNIVERSITY OF Michigan, 1921, worked for City Engineer, Saginaw, Mich.; surveying and drafting; have also done some small concrete work.

B-1139: INDUSTRIAL ENGINEERING, ENGIneering sales or cost accounting; 5 years' experience planning production control of large factories, standardization, time study, feeds and speeds, efficiency work, etc., taken full C. P. A. course.

B-1138: CONSTRUCTION ENGINEER, MAchine designer on development work, experimental, inventions, etc., engineering sales, 12 years' design and construction of mining and milling plants, 4 years coal handling plants, boiler equipment, tipples, skip hoists, etc., 3 years special machine design; 1907 to 1915 chief construction engineer of large mining company, in full charge of design and construction of 4,000 ton concrete mill.

B-1138-A: ELECTRICAL RESEARCH AND development, mechanical development, mechanical drafting; 9 years experience beginning with Ellington Electric Co., and later with Electric company I organized to build small motors, exservice man, air pilot.

B-1137: SALES ENGINEER, OUTSIDE BUILDing construction, superintendent, surveyong and railroad work, experience with Illinois Highway Dept., asst. to City Engineer, Junior M. W. S. E.

B-1136: SUPT. LIGHT MFG., VALUATION work, efficiency work, Member American Society Mechanical Engineers M. E. graduate, Purdue University, 5 yrs. Griffin Wheel Co., 3 yrs. mechanical valuation work Northern Pacific Ry., 1 yr. supt., Majestic Co., manufacturers of warm air furnaces.

B-1135: SALES ENGINEER, MECHANICAL engineering; production, 16 yrs. in connection with cranes and conveying machinery.

B-1134: PRODUCTION ENGINEER AND MANager, efficiency man; have been installing Gault Production Methods in the manufacturing plants since 1919.

B-1133: ARCHITECTURAL ENGINEER, structural steel and concrete designer, heating and ventilating designer, drafting and estimating, formerly with Stone & Webster, Engineering Co., Boston.

B-1132: MINING ENGINEERING, CONTRACTing, steel construction, graduate 1921 Michigan College of Mines, in mining engineering and metallurgy; 4 mos. railroading, steam shovel work, surveying, State Highway work, timber valuation.

B-1131: MAINTENANCE ENGINEER draftsman, sales engineer; 20 years' experience in steel work as draftsman, erecting engineer, safety, lubrication, furnace and combustion engineer, chemist and heat treating engineer; during war U. S. Army appraiser.

B-1130: INDUSTRIAL AND MECHANICAL engineer; gas and fuel oil equipment, mechanical and electriacl installations; automobile and small electric units, about 6 years with the above.

B-1129: DESIGNING, VALUATION AND sales engineer; experience in reinforced concrete steel buildings and bridges; graduate of Cooper Union, 1908.

B-1127: GRADUATE MINING ENGINEER, University of Montana, 1910; construction work for Wheel Co., foundry engineering, Sanitary Mfg., routing material, drafting, designing and general engineering work.

B-1126: MINING ENGINEER, MILL WORK, 2 yrs. in Copper Leaching plant; graduate of Michigan College of Mines, 1921.

B-1126-A: ELECTRICAL PURCHASING ENGIneer, mechanical engineer, sales engineer; 5½ years as electrical engineer on heavy coal and handling machinery.

B-1125: CONSTRUCTION OR APPRAISAL OF railroad property; salesman, technical line; factory management; will take temporary work; 8 yrs. R. R. construction and maintenance; Capt. 1gth Engineers A. E. F., 27 mos. construction and appraisal of army supplies.

B-1124: DRAFTSMAN, STRUCTURAL ESTImating; 3 yrs. evening course with Armour Institute and 2 yrs. other evening schools; 7 yrs. mechanical and structural drafting and designing railway cars, chemical and packing plant equipment, rotary car dumpers and tractors; also some die and tool work.

B-1123: TWO YEARS TRI-STATE COLLEGE of Engineering; transitman, rodman; experience in subdivision and construction of army camps, bridge, grade separation, sewers, street paving, railroads, pipe lines, and location and valuation.

B-1122: CIVIL ENGINEER WITH CONS. ENG. Railroad and municipal surveys; graduate Illinois 1916; assistant to City Engineer.

B-1121: WITH CONSULTING MECHANICAL Engineer, A. S. M. E., Eng. Soc. West., Penn.; graduate Carnegie Tech. 1916; mechanical draftsman.

B-1120: STRUCTURAL DETAILER OR checker; 14 yrs. experience; 11 yrs. Bridge Co.

B-1119: ASSISTANT MINING ENGINEER, surveyor, assayor; western location desired.

B-1118: MECHANICAL DRAFTSMAN; 7 YRS. experience in layout of power plant, refrigerating plant, paper mills, heavy machinery, etc.

B-1117: MECHANICAL ENGINEERING, drafting, construction; prefer position with industrial firm using large quantity of steam in process of manufacturing as steam engineer and designing engineer; graduate University of Kentucky, 1904.

B-1116: ELECTRICIAN, MAINTENANCE; hospital X-Ray or operating room; 7 yrs. chief electrician Hotel Cecil, London.

B-1115: SUPT. MFG. OR ASS'T. SUPT.; GEN-foreman; Assoc. M. W. S. E.; familiar with punch press, drill press, milling machine, screw machinery, production, time study, rate and labor saving devices.

B-1114: MECHANICAL DRAFTSMAN, SALES Engineer; 6 yrs. of mechanical detailing, designing and checking of machinery and structural steel; 2 yrs. Washington University, St. Louis 1915, mechanical engineering.

B-1113: STRUCTURAL STEEL, DESIGNER OR checker; reinforced concrete; surveying or general engineering; graduate C. E., Colorado, 1914; 5 yrs. experience in structural steel detailing, checking and designing.

B-1112: CIVIL GRADUATE WITH 9 YEARS' field and office experience in railroad building construction; wants position with engineering or contracting firm.

B-1111: LANE TECHNICAL GRADUATE, DEsires beginners' position in mechanical engineering.

B-1110: GRADUATE C. E., CORNELL UNIversity; 1 yrs. construction and designing experience on general concrete and building work.

B-1109: MEMBER A. I. E. E., 1 YR. ELECtrical testing, 4 yrs. sales engineer, Electric Co.

B-1108: PRODUCTION ENGINEER, SUPT. IN wood and metal work; B. S. M. E. Purdue '03; 12 yrs. shop and office experience.

B-1107: DESIGNER AND CHECKER OF structural steel and reinforced concrete; also machinery for grain elevators; Assoc. M. W. S. E.

B-1106: ELECTRICAL ENGINEER, EITHER manufacturing, constructing or teaching; Member A. I. E. E., motor testing; electrical construction foreman; graduate Cornell 1920.

B-1105: ASSISTANT ENGINEER, FIELD OR office; appraiser on roadway and structures; assistant engineer for engineering firm or contractor; experience in geodetic surveys, steam and electrical railway surveys, maintenance, valuation and appraisal; structural steel detailing and design; municipal engineering and some building construction; total 11 yrs.

B-1104: GRADUATE 1921 UNIVERSITY OF Manitoba in electrical engineering; desire beginners' position.

B-1103: RAILROAD ENGINEER, CONSTRUCtion, valuation and maintenance of way; highway and irrigation; 10 yrs. in railroad work; 2 yrs. in city and highway; 1 yr. in irrigation.

B-1101: RODMAN, DRAFTMAN; 3 YRS. AT Lewis Institute; 3 mos. with Hancock County Highway Dept.; student M. W. S. E.

B-1100: ARCHITECTURAL CHECKER AND draftsman; estimating and superintendent of construction; 2 yrs. experience in large architectural and engineering offices and with U. S. government ;licensed architect.

B-1099: MECHANICAL DRAFTSMAN WITH auto engine; experience 1 yr. with Fairbanks Morse; graduate University of Michigan, mechanical engineering in 1918.

B-1098: COST AND VALUATION ENGINEER on plant or industrial engineering work; 7 yrs. railroad, 1 on location, 2 on construction, 4 on maintenance of way; 2 yrs. cost engineer Refining Co.

B-1097: MEMBER A. I. E. E., MANAGER OR superinteident of Electrical Utilities; electrical engineering of any kind.

B-1096: ASSOC. A. S. C. E., Cornell C. E. 1915; general civil engineering construction work with consulting engineer and contractors; design and drafting; 2½ yrs. on road work.

B-1095: CIVIL ENGINEERING POSITION; Junior W. S. E., 7 mos. C. M. & St. P. Ry., Engineer of designs office; 5 mos. Illinois State Highway.

B-1094: ASST. PROFESSOR IN MECHANICS and professor of mechanical engineering; mechanical engineer with firm making pneumatic riveters, molding machinery, hoists, etc.; in responsible charge of design, must testing; graduate of Mass. Institute of Technology 1899; member A. S. M. E. and W. S. E.

B-1093: CIVIL ENGINEER OR SUPT. OF construction; graduate Sheffield Scientific School 1902; 18 yrs. as engineer and contractor's supt. on railroads, paving, highways, sewers, bridges, etc.

B-1092: ASS'T. ENGINEER CONSTRUCTION; draftsman and estimator; land or real estate surveyor; municipal engineering, 5 yrs. electric railway construction; 2 yrs. railroad construction; 10 yrs. railroad valuation; 4 yrs. real estate and right of way; Prin. Ass't Engr., in charge of right of way Keokuk Dam with Stone & Webster.

B-1091: STRUCTURAL STEEL DESIGNER, checker and detailer; construction work; 2½ yrs. construction of viaducts and subways, cement testing; squad boss on structural steel; member A. S. C. E., graduate University of Illinois.

B-1090: OPERATING STEAM ENGINEER, 35 yrs. experience; desires power plant large or small, not averse to doing own firing, but prefer engine work only; Chicago license.

B-1089: STRUCTURAL DESIGNER, MATHEmatical investigator; designer of reinforced concrete and steel bridges; speaks Greek and French; Assoc. M. W. S. E.

B-1088: M. W. S. E. and A. S. M. E., 15 YRS. experience in building design construction, plant engineer and master mechanic; Army Engr. Corps.

B-1087: JUNIOR DRAFTING, SURVEYOR'S helper; Technical High School training and general mechanical work.

B-1086: DESIGNING STRUCTURAL ENGIneer; contracting engineer; instructor of structural engineering; 25 yrs. general structural engineering and contracting. Twice Ch. Engineer.

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TECHNICAL MEETINGS

Thursday, December 1st

H. S. Osborne—Transmission Engineer, American Telephone and Telegraph Co., New York. *"The Practical Application of the Telephone Repeater."*

Monday, December 5th

Frances Shenehon—Consulting Engineer, Minneapolis. *"Economic Features of the St. Lawrence-Great Lakes Waterways Project."*

Thursday, December 15th

George J. Ray—Ch. Engineer, D., L. & W. R. R., Hoboken, N. J. *"Economic Considerations of Line Revision Work on Delaware, Lackawanna & Western R. R."*

Monday, December 19th

H. H. Wagenhals—Associate Sanitary Engineer for United States Public Health Service, Cincinnati, Ohio. *"Operation of Sewage Disposal Plants."*

Friday, December 16th

Joint Meeting W. S. E., A. I. E. E., A. S. M. E., A. I. & S. E. E.

W. S. Hall—Electrical Engineer of the South Works of the Illinois Steel Company, South Chicago. *"Application of Electric Power to the Iron and Steel Industry."*

YOUNG MEN'S FORUM

Saturday, December 3rd

S. H. Scheel—Manager Investment Bureau, Commonwealth Edison Co., Chicago. *"Selling the Utilities to the User."*

JOURNAL OF THE
WESTERN SOCIETY *of* ENGINEERS

Volume XXVI DECEMBER, 1921 Number 12

TECHNICAL PAPERS

THE NORTHWESTERN ELEVATOR EXPLOSION

By David J. Price*

Presented October 3rd, 1921.

The explosion on March 19, 1921, in the Northwestern Elevator at South Chicago, Ill., operated by the Armour Grain Company, has attracted more attention to the subject of Dust Explosion Prevention than any previous occurrence of this nature. As a result of the great damage to the elevator and the proportions of the explosion, numerous requests for information concerning this disaster have been received from all parts of the world where grain is milled or handled.

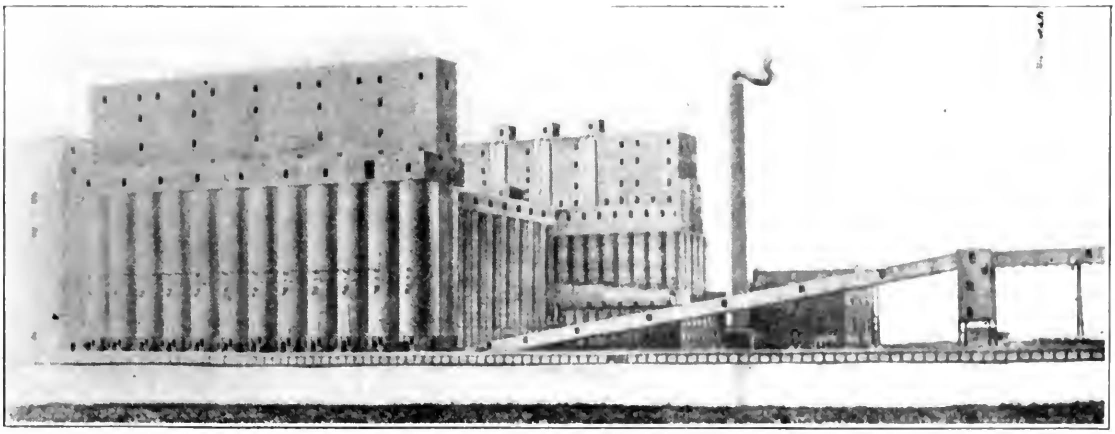


Fig. 1.—View of the Northwestern Elevator at South Chicago, taken before the addition was made to the storage section at the north side of the plant.

As a result of the explosion six men lost their lives and several others were injured. Parts of the plant were completely destroyed while other sections were damaged to such an extent that it was necessary to tear them down. The total loss to grain and property has been estimated at approximately $3,750,000. While every effort was made to establish definitely the cause and point of origin of this explosion, the principal purpose of the investigation was to obtain data which would assist in preventing similar disasters in other industrial plants of the country and also aid in designing and constructing mills and elevators so that the dust explosion hazard can be controlled if not entirely eliminated. This article reviews the result of the inves-

*Engineer in charge of Development Work, Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

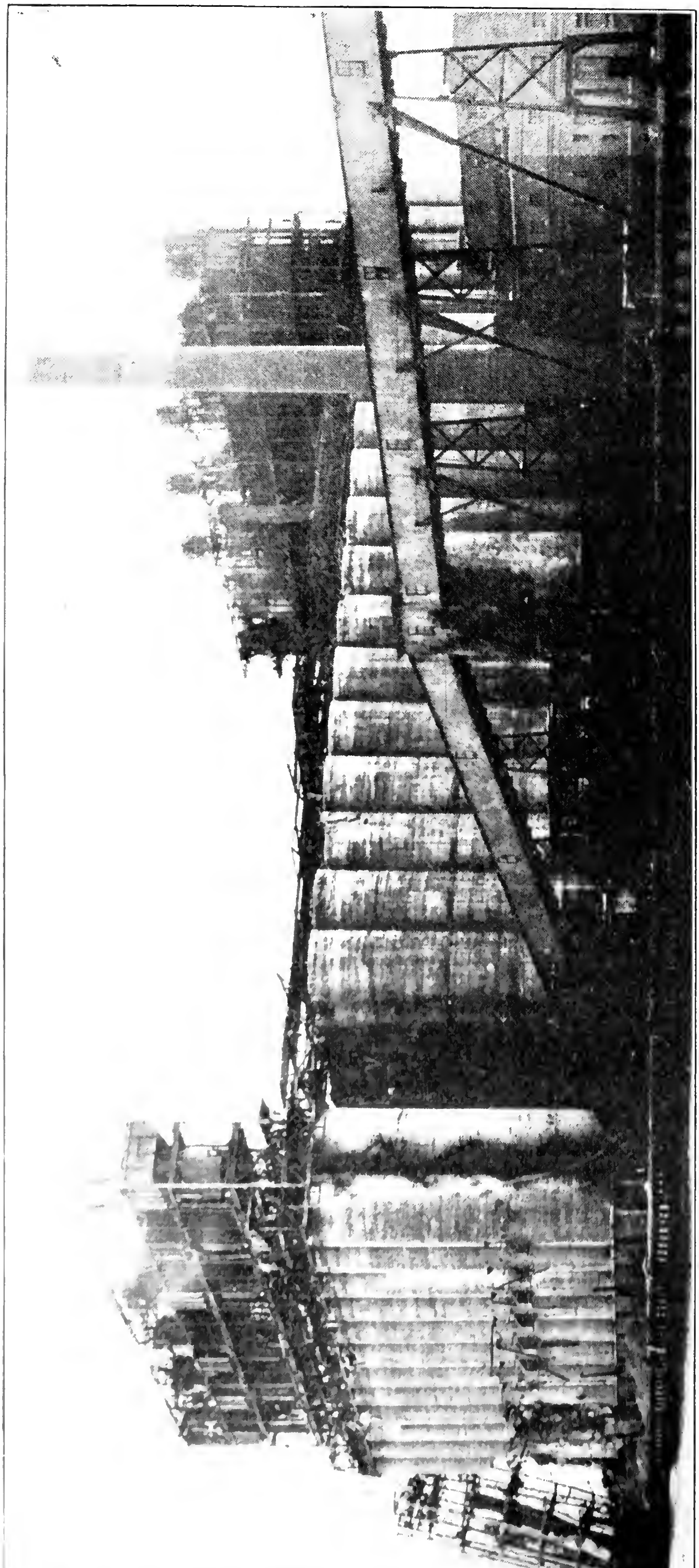


Fig. 2.—This view taken from across the Calumet River shows the northeast corner of the huge elevator as it looked after the explosion. A piece of concrete or steel apparently was blown high in the air and in falling knocked out a section at the top of the brick chimney.

tigation by the Bureau of Chemistry of the United States Department of Agriculture and contains a number of recommendations based on the result of the investigation.

The Northwestern Elevator was built by the Chicago & Northwestern Railway Company to handle the large amount of grain shipped to Chicago over their lines. Plans were submitted by elevator engineering companies for a 10,000,000 bushel elevator, and in July, 1914, the railroad company began driving piles for the elevator foundation.*

The dust collecting system for the house was supplied by the Cyclone Blow Pipe Company and consisted of an expansion chamber, cyclone collectors and the

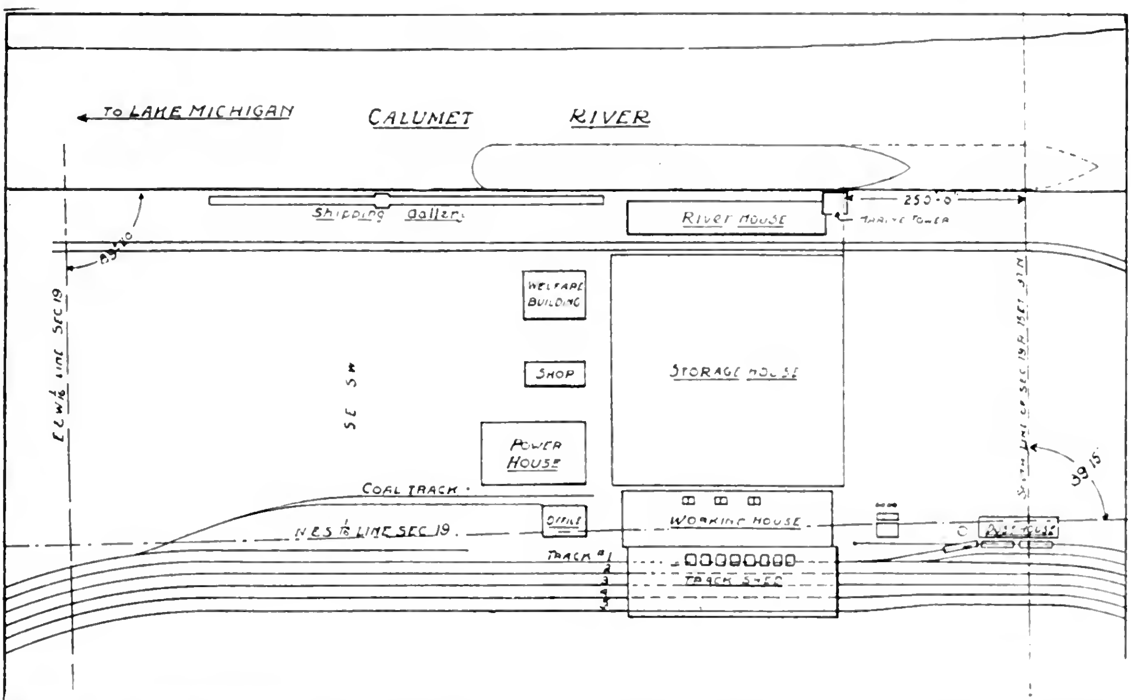


Fig. 3.—Plan showing layout of buildings and rail and water facilities of C. & N. W. Ry. Elevator.

necessary fans to blow the dust to the collectors and convey it after it had settled to the dust house, a concrete building 106 x 28 feet located about 194 feet south of the work house. The large expansion chamber and 40 cyclones located between the work house and the storage section received the dust from the cleaners and the floor sweeps. Eight floor sweeps were installed in the basement and eight on the first floor, while the cupola was supplied with sixteen. The expansion chamber contained six vent stacks which extended above the roof level of the storage section between it and the work house. The dust discharged by the cyclone was blown by fans located in the work house to two large cyclones on the roof of the dust sacking house. These cyclones discharged the dust to eight Monitor Dust Packers which sacked the dust for shipment. While this collecting system provided for the removal of dust from the cleaning machines and the dust swept up on the floor when the plant was being cleaned, no aspiration was permitted on the grain entering the house and no suction was applied on elevators or conveyors.

ACCOUNT OF THE EXPLOSION.

The time at which the explosion occurred has been set at about 6 o'clock, possibly a few minutes after the hour, and at least two separate and distinct explosions

*C. & N. W. Ry. Co. Terminal Grain Elevator: by W. H. Finley, Pres. C. N. W. R. R. Journal Western Society of Engineers, Vol. XXIV., No. 5. May, 1919, p. 307.

occurred with the last and heavier one about ten seconds after the first. The first explosion must have been quite heavy but small in comparison with the second or final blast which wrecked the greater part of the plant. The night shift of six men came on the job about 4 o'clock and were the only employees in the elevator when the explosion occurred. All of these men were killed.

Windows were broken in business houses and residences five miles from the elevator. The shock was felt for many miles and was strong enough to shake buildings more than a mile from the plant. Reports state that the shock was distinctly felt in Benton Harbor, more than 50 miles away on the eastern shore of Lake Michigan, where windows were rattled by the blast. Persons 100 miles away reported hearing the explosion.

It is interesting to note several incidents previous to the explosion which possibly had some bearing on the cause of the disaster. The elevator, with the exception of the driers, had been shut down at noon of the day the explosion occurred. Two sections of driers continued in operation until 4:30 in the afternoon. A number of painters, employed in repainting the steel work around the plant, and the regular force of elevator employees on the day shift with the exception of a few employed in the drier, left the elevator at noon. The drier-men left between 4:30 and 5 o'clock, after the driers were shut down. The night force when they reported for work about 4 o'clock started cleaning the driers. This work consisted of brushing down the dust around the garners above the driers and removing all foreign material such as sticks, pieces of burlap, etc., which would not go through the grating in the bottom of the garner. The driers were also to be brushed down and given a thorough cleaning and a force of men was expected to complete on Sunday the part of this work not finished by the night force. It was brought out during the investigation that there had been a fire in the driers the Saturday previous to the explosion. This fire was first discovered about 5:00 a. m., and it was thought to have been extinguished. However, it broke out again about 3:00 p. m. of the same day and was extinguished by use of a hose line. Another fire was reported to have occurred in the boot of one of the shipping legs about one month previous to the explosion.

As shown above, there were probably a number of times when the spark or flame necessary to start a dust explosion was present in the Northwestern Elevator, but due to the fact that other conditions were not right no explosion occurred. Experiments have shown that to produce an explosion it is necessary to have a sufficient quantity of dust in suspension in the air with certain limits on the size of the dust particles and the moisture content of the dust, and a spark or flame to ignite the dust cloud.

Previous observations have shown that a large majority of the explosions investigated have occurred at times when the temperature is unseasonably high and the relative humidity low. These observations have again been borne out by the reports of the Weather Bureau Station at Chicago as given below:

WEATHER CONDITIONS.

Relative Humidity.				*Temperature.*			
Date	7:00 a. m.	Noon	7:00 p. m.	Date.	7:00 a. m.	Noon	7:00 p. m.
Mar. 15, '21....	91	84	69	Mar. 15, '21....	54.6	63.1	51.0
Mar. 16, '21....	46	68	64	Mar. 16, '21....	35.9	41.2	42.8
Mar. 17, '21. ..	86	64	95	Mar. 17, '21....	42.8	56.2	37.6
Mar. 18, '21....	93	90	56	Mar. 18, '21....	37.0	43.8	59.7
Mar. 19, '21....	88	67	58	Mar. 19, '21....	60.1	73.3	72.5
Mar. 20, '21....	89	83	97	Mar. 20, '21....	64.1	72.8	66.
Mar. 21, '21....	91	..	..	Mar. 21, '21....	40.		

It will be noted that on Saturday, March 19, the temperature was exceptionally high, while on Friday, the 18th, and Saturday, the 19th, the relative humidity was comparatively low.

Reports on the dust condition of the elevator just previous to the explosion differ considerably. To one unfamiliar with general conditions in grain elevators as they are at present operated, and ignorant of the amount of dust created during the handling of grain, the Northwestern Elevator seemed dusty, while others accustomed to working in plants of this kind considered the elevator clean.

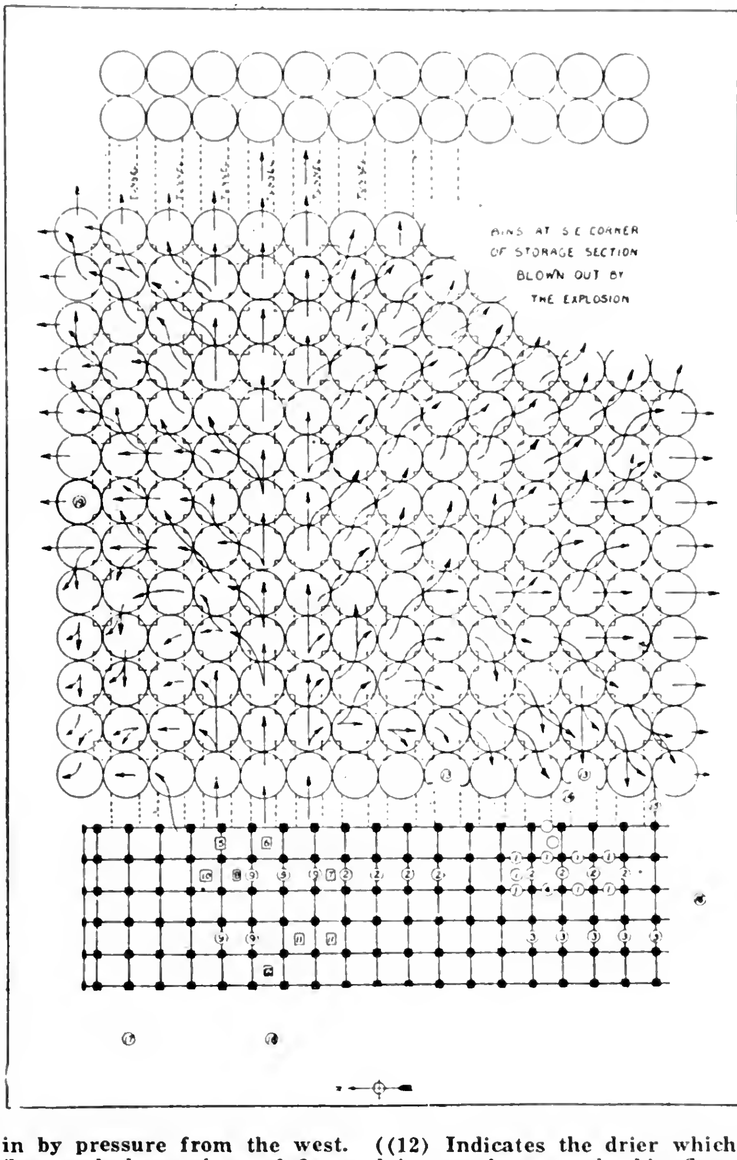


FIG. 4.—(1) Indicates points at which the beams and girders supporting the first floor of the work house were forced down, showing that there was a pressure from above, probably due to a minor explosion in this end of the work house. (2) Indicates points at which the cross braces between columns on the first floor of the work house were forced up and towards the south, indicating pressure from below and from the north. A number of these braces showed signs of having been struck by heavy objects, probably pieces of concrete or machinery blown from other sections. (3) Indicates points at which the outer or western part of the cross braces between columns on the first floor of the work house were forced up and towards the south, showing that the pressure here was from below and from the northeast. (4) Indicates the point at which the floor beam was forced down more than any of the others surrounding it.. (5 and 6) Indicate clippers which were blown in opposite directions: number 5 being blown towards the north, while number 6 was pushed towards the south. There are no signs of extreme violence between the machines but they appear to have been tilted and dropped into their positions by a raising of the floor between them. (7) Indicates an elevator leg which has apparently been forced in by pressure from the west. (8) Indicates an elevator leg in which there was evidence of a slight internal explosion. (9) Indicates points at which the cross braces between the columns on the first floor of the work house were forced up by pressure from beneath. (10) Indicates the elevator shaft with evidence of pressure from below jaming the shaft with twisted steel and debris. (11) Indicates legs which were apparently blown in by pressure from the west. ((12) Indicates the drier which was practically destroyed on the first floor and shows signs of fire and intense heat on the bin floor. Surrounding spouts in the cupola of the work house also show signs of intense heat on the sides adjacent to this leg. (13) Indicates bins of the storage section blown in from the northwest by pressure from the first floor of the work house, or the area between the work house and the storage section occupied by the dust collectors. These bins were not blown in above the ceiling of the first floor of the work house. (14) Indicates the point at which the bin foundation was blown out by pressure under the storage section. (15) Indicates the point at which one of the beams between the work house and the storage section has been forced down and towards the south, indicating pressure from above and from the north. (16) The row of columns at the south end of the work house was blown out by pressure on the first floor. The position of the basement wall below the columns indicates that it had been blown out by an explosion in the basement before the columns fell. (17) At this point the steel framework supporting the tracks over the receiving hoppers was lifted from the concrete piers and carried with the box cars which had been standing in the track shed, about 12 feet west of its original position. (18) At this point the frame work of the track shed was forced about 15 feet west of its original position. (19) The bottom of this tank, the seventh from the northwest corner of the storage section, was blown out by pressure from above after the equipment in the tunnels under the tanks had been wrecked. The entire block of tanks at the northeast corner of the storage section was forced about half a foot north and east from this point.

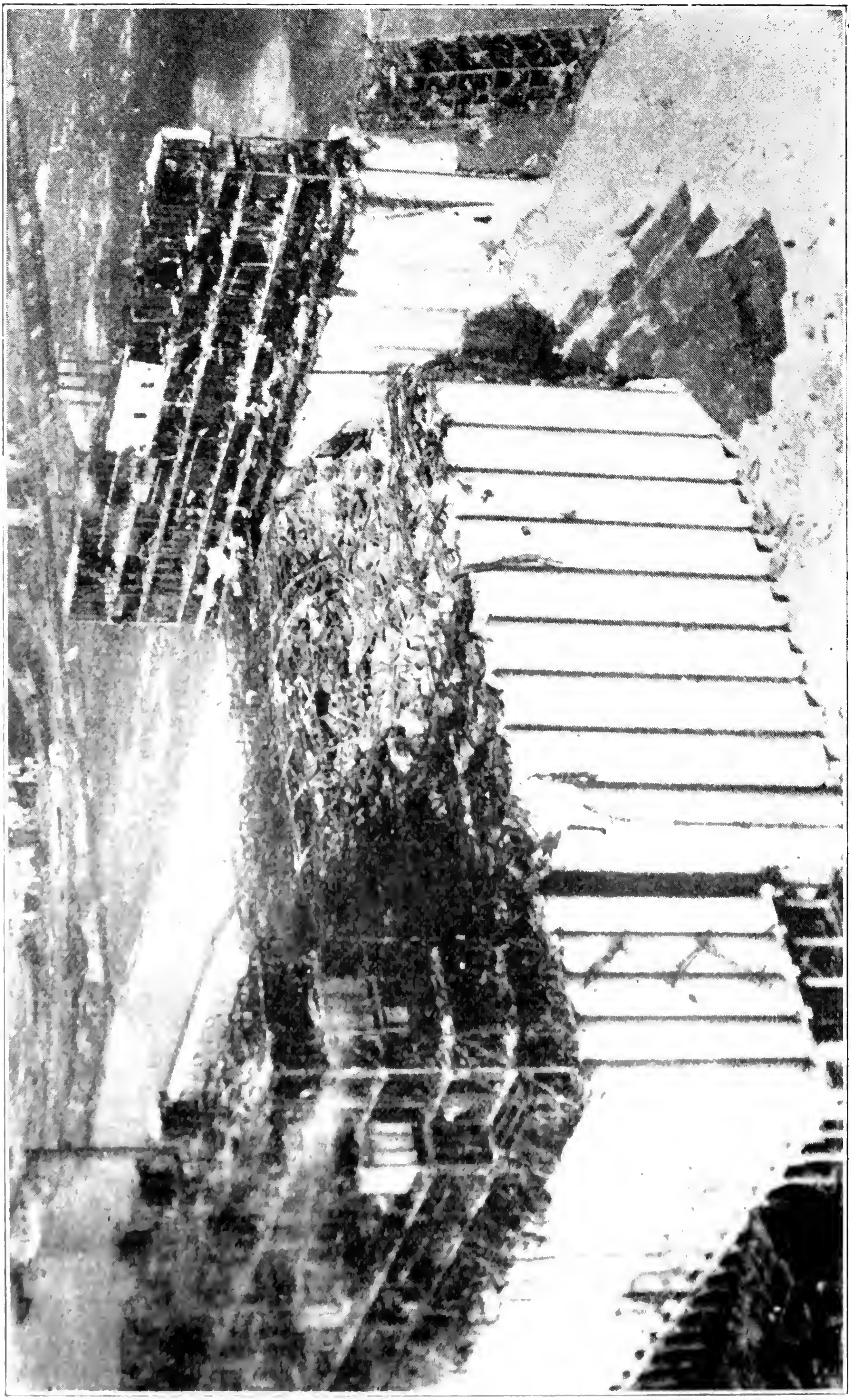


Fig. 5.—An aeroplane view taken close to the southwest corner of the work house cupola showing the damage to this section of the plant and the destruction of the steel frame work over the storage section.

An inspector for the Chicago Board of Underwriters, who had visited the elevator Tuesday previous to the explosion, reported the plant in fair condition, which indicated that as far as fire hazards were concerned conditions were satisfactory. However, this inspection covered only conditions which would have some bearing on the starting of a fire in the plant and was not intended to cover dust explosion hazards. From all reports obtained it is assumed that dust conditions at the Northwestern Elevator were about the same as at the average terminal elevator. Under present regulations prohibiting the application of suction to the grain for the removal of the dust previous to weighing, it is practically impossible to prevent the accumulating of dust about a large elevator.

As has been stated above, workmen were busy cleaning a section of the plant at the time the explosion occurred. In brushing down the walls, beams, ledges, etc., about the plant large quantities of dust were naturally thrown into suspension. This fine dust which remains in the air as a dust cloud needs only a spark to start the initial explosion which stirs up other dust through which the flame propagates. The cleaning process had been going on for about two hours before the explosion occurred and undoubtedly a large quantity of dust had been thrown into suspension. It has been shown that weather conditions were about the same as prevailed at the time previous explosions occurred. It was also shown that at times sparks were produced and small fires occurred in the elevator. Apparently all these conditions which are necessary before a dust explosion can occur prevailed at about 6 o'clock Saturday evening, March 19, and the original dust ignition fed by dust in the elevator developed into the disastrous explosion which wrecked the plant.

Damage to Elevator.—Since the Northwestern Elevator was the largest plant of its kind in the world it would be natural to suppose that the explosion which wrecked it was the most violent explosion of dust that has ever occurred. This supposition is correct. Although the loss of life in other explosions has been greater than at the Northwestern Elevator, and the destruction may have been more complete in other plants in which dust explosions have occurred, the blast which wrecked this huge modern grain handling plant was without doubt the most violent.

The explosion of starch dust which wrecked the large plant of the Douglas Starch Company at Cedar Rapids in May, 1919, caused the loss of 43 lives and property damage amounting to $2,194,700. In this case the destruction was perhaps more complete than at the Northwestern Elevator, due to the fact that a number of the buildings at the starch works were of brick and frame construction. In the elevator explosion at Port Colborne, Ontario, in August, 1919, ten men lost their lives and the property loss was estimated at $750,000. The explosion at the Murray Elevator in Kansas City in September, 1919, caused the loss of 14 lives and property damage amounting to $465,000. In each of the two elevator explosions mentioned above the loss of life was greater than at the Northwestern Elevator, but this is due, probably, to the fact that the plant at South Chicago was not in operation and only a few men were at work, for every man in the elevator was killed. In no previous explosion has the tremendous force which may be produced by a dust explosion been so evident as in this case in which a modern grain handling plant of reinforced concrete and structural steel was so extensively damaged. Words and pictures are inadequate to describe the force of the explosion or the damage to the elevator.

The river house was probably more extensively damaged than any other section of the plant. It is the opinion of some of the investigators that this part of the elevator was almost blown into the river by the explosion. As the close up picture

of the river house foundation shows, every piece of concrete construction within sight has been cracked, broken, or blown out entirely. Nothing except the wharf wall remains undamaged in its original position. A number of the river house bins at the south end of the house were blown out. Steel and concrete were torn apart by the explosion and debris hurled across the river. Other bins of the river house

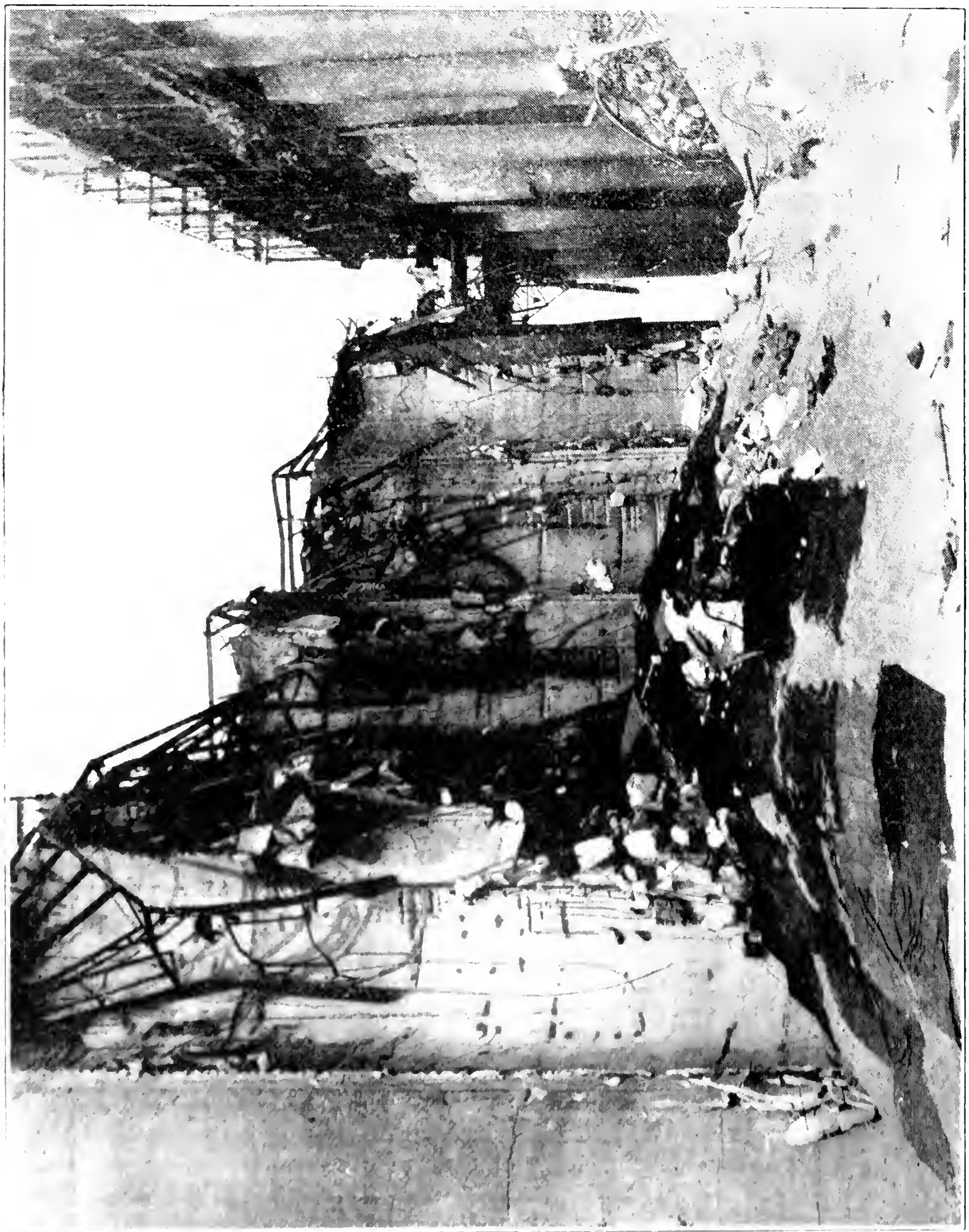


Fig. 6.—The concrete storage bins at the southeast corner of the storage section which contained several hundred thousands of bushels of grain were blown to pieces. The spilled grain was covered with tarpaulins to protect it until salvaging work could be started.

were cracked, foundation walls were cracked and steel work in the cupola bent out of shape. It will probably be necessary to tear down part of this section of the plant in order to rebuild. The marine tower was wrecked. Some of the machinery will be salvaged but the structural steel frame work and the marine leg will probably have to be rebuilt entirely.

At first sight the storage section did not appear to be seriously damaged with the exception of the storage bins blown out at the southeast corner. However, closer inspection showed that the damage was more extensive. The explosion in the tunnels under the storage bins was apparently very violent. It is important to note that an explosion of grain dust would produce sufficient force to lift these huge concrete storage tanks from their foundations, but evidently this is what happened. Sixteen or more of the cylindrical bins at the southeast corner of the storage section were blown to pieces and sections of others blown out. At the northeast corner of the storage section the results were different. At this point the bins, a number of them full of grain, were lifted from their foundations and moved from their original position. Approximately 40 bins at this corner of the storage section were moved nearly half a foot north and east of their original position. Cracks showing between other bins and their foundation piers indicate that they were also lifted by the explosion. The tanks and the grain they contained would probably weigh 300,000 tons. This gives some indication of the tremendous force of the explosion. The structure above the storage bins was totally destroyed.

The work house was perhaps the least damaged of the elevator buildings. The equipment and lighter parts of the structure were destroyed or severely damagd but the bins and supporting columns appear to be in good condition. The columns and foundation wall at the south end of the work house were blown out but this does not effect the main supporting columns under the bins. The concrete slabs forming the first floor of the work house were blown up and completely destroyed but only a few of the floor beams have been damaged. Many of the cross braces between the first floor columns were damaged by flying debris. All of the machinery on this floor has been blown from its original position and badly damaged. Some of the work house bins were damaged at the top and on the east side of the house several have been blown out. Most of the elevating legs were destroyed but some of the elevator heads remained intact and steps were taken at once to repair one of the legs that was the least damaged in order to remove the grain from the house. It was necessary to straighten and replace the steel plates forming the leg, replace the section of belt destroyed at the boot, and rebuild entirely the lower part of the leg below the bins. The cupola of the work house was originally built with light walls of gunite and when the explosion reached this section of the house little resistance was offered. The result was that the equipment in the cupola and the frame work itself show little damage compared to the destruction in other sections of the plant. The force of the explosion, however, was sufficient to push over the concrete bleaching towers along the east wall of the cupola. These towers fell on the top of the storage section.

The drier house, and the track shed which were practically a part of the work house, are a total loss. As shown in the photographs of the wreckage in front of the work house, scarcely a piece of structural steel which helped to form the frame work of this part of the plant can now be found in its original shape. Steel columns were broken, beams and girders were twisted into queer shapes and the heavy girders over the receiving pits with box cars still on the rails were lifted and hurled with the entire mass of twisted steel about 15 feet from their original position. In falling the drier garners which were on a level with the work house bins turned in towards the bins and settled into what was formerly the basement of the track shed. The shipping gallery, which had never been used, was damaged very little by the explosion, probably due to the fact that no dust had accumulated in it.

Practically all reports stated that the explosion originated at the west side of the elevator and the investigation substantiated these statements. In tracing the various paths followed by the explosion through the tunnels and into various sections of the plant it was found that these paths centered at a point in the basement of the work house close to the western side where the track shed and driers joined the work house and about the sixth bay from the north end of the house where one of the drier legs was installed. This point is about one-third the length of the house measuring from the northern end.

This evidence does not indicate necessarily that this was the point where the dust was first ignited, but shows that this is the point where the flames met the first large dust cloud, and the first large explosion occurred. The first ignition of the dust may have been at a point some distance from this location just as a fire brand may be thrown or blown into a pile of combustible material from a point some distance away.

The facts which were taken into consideration in determining the point of origin ,or point at which the first heavy explosion occurred, are shown by the chart Fig. 4, which is the plan of the first floor of the work house, and the tunnels under the storage section. The explanatory notes with numbers showing the various points of evidence indicating the path of the explosion.

Arrows show the course which the explosion probably followed in spreading through the tunnels and around the piers under the storage section. The evidence indicates that it probably spread north and south from the sixth tunnel, counting from the north end of the plant. There were plenty of openings through which the flames could propagate from the basement or first floor of the work house to the cupola. Evidently the explosion reached the bin floor near the point where the drier leg previously referred to came up through a leg bin, since the floor has been blown upward at this point. It propagated throughout the work house cupola from this point and spread into the storage section where it followed the belt conveyors running over the fourth anw fifth rows of bins counting from the north side of the house and spread in a fan shape to the north and south, probably reaching its greatest intensity at the southeast corner of the storage section where the sixteen storage bins were blown out.

The explosion entered the river house through the tunnels leading from the basement of the storage section and through the bridges leading to the river house from the tops of the storage bins. The marine tower was probably forced into the river by the explosion which blew out the southeast corner of the storage section.

THEORIES ADVANCED AS TO CAUSE OF EXPLOSION.

As is usual in disasters of this kind, a number of theories regarding the possible causes of the explosion were advanced, but the facts brought out during the investigation did not substantiate many of them.

The facts brought out in hearings following the explosion, substantiating or eliminating from further consideration the various theories advanced, are given below:

1. *Smoking in the Elevator.*—As far as could be learned, all employees at the elevator were aware of the danger from smoking, or the use of open flames in dusty atmospheres. It is considered unlikely that they would forget this danger and strike a match or smoke while engaged in cleaning the driers, an operation which necessarily threw into suspension a large amount of dust.

2. *Use of Oil Lanterns in the Elevator.*—The finding of an oil lantern in a section of the elevator, and the fact that the watchman used lanterns in making their rounds at the plant gave rise to the theory that the explosion may have been due to this cause. However, this was considered improbable since the lantern was not found in the section of the plant where the explosion originated.

3. *Bomb Placed in the Elevator.*—The evidence indicated clearly that the plant was wrecked by a dust explosion. No evidence of a bomb explosion or any reason for placing a bomb could be discovered, and this theory was therefore eliminated.

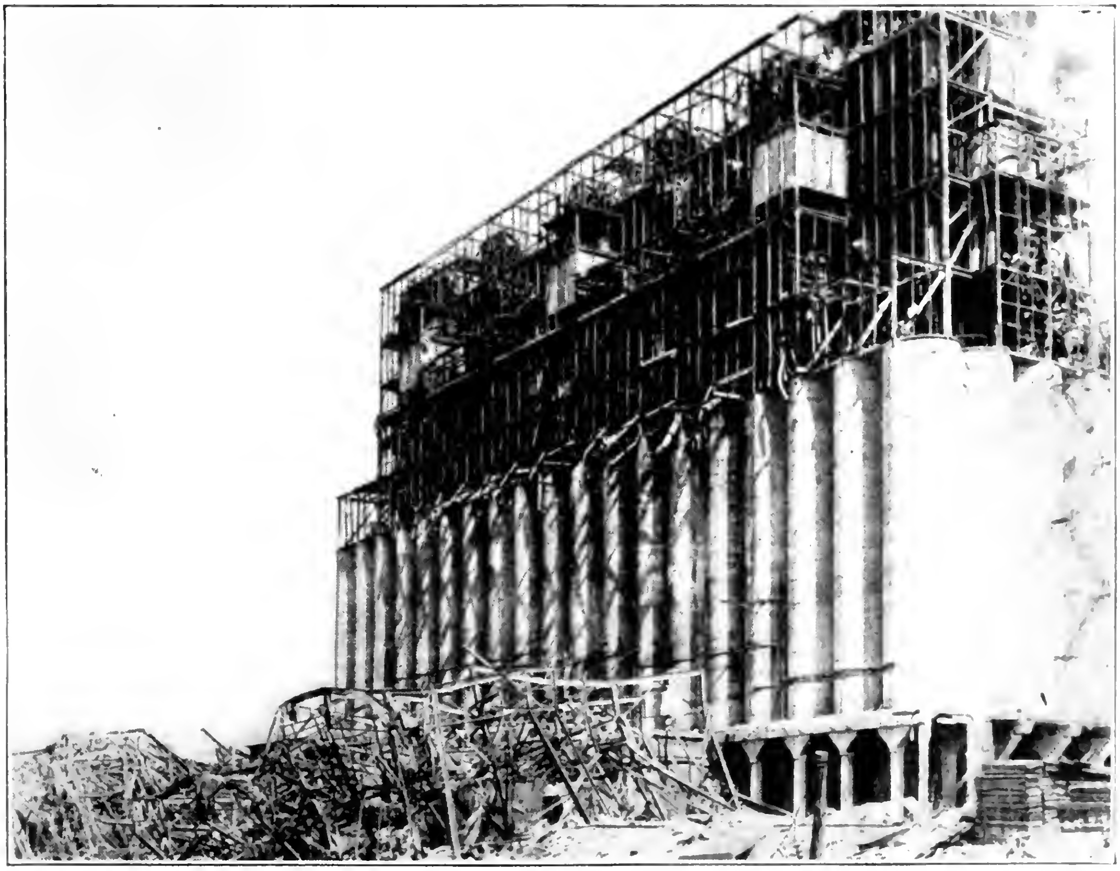


Fig. 7.—The work house was not as seriously damaged as other sections of the plant. This view of the west side and south end of the house shows the grain tanks and their supporting columns still intact. The wreckage in the foreground is from the destroyed drier house and track shed.

4. *Short Circuit in the Electric Wiring.*—Due to the condition of the elevator after the explosion, it was practically impossible to obtain any information bearing on the theory that the explosion was caused by a short circuit in the electric wiring. All wiring throughout the plant was in conduit and had been regularly inspected and reported in good condition. Extension lights or portable lamps on long cords were used throughout the elevator and it is reasonable to suppose that dragging these lamps from place to place as is common in plants of this kind wore off the insulation. In the hearings following the explosion the electrician at the elevator reported that he kept close watch on all equipment of this kind and to the best of his knowledge all extension cords were in good condition. The workmen at the elevator, when the explosion occurred, were engaged in cleaning the garners over the drier and did use extension cords for this work. The original ignition of the dust by sparks due to a short circuit in one of these cords may be considered a possible, but not a probable cause of the explosion.

5. *Spontaneous Combustion.*—Spontaneous combustion, the usual theory advanced when the real cause of a fire is unknown, was given in this case. It is known that oily waste will ignite spontaneously and certain prepared feeds and grain dust when stored in bulk will heat and ignite, or smolder. The conditions necessary for such ignition are so exact that cases of this kind are rare. This theory may be considered a possible but very improbable cause.

6. *Fire in One of the Cleaning Machines.*—During an inspection of the elevator in connection with the investigation following the explosion, one of the cleaning machines was found to have been damaged by fire. The frame of this machine was constructed of wood covered with metal. The 4 x 4 timbers forming the frame were charred and in some places resembled charcoal. Some of the investigators advanced the theory that this wood had been burning for some time within the sheet metal covering without being noticed by the elevator employees. It was assumed that this fire broke out late Saturday afternoon, and ignited the dust stirred up during the cleaning of the drier. Considering the possibility that this machine was damaged by the fire in connection with the explosion, it seems best to eliminate it as a probable cause of the explosion.

7. *Ignition of Dust on Electric Lamps.*—The ignition of dust which had settled on the globes of electric lamps in the elevator was another theory advanced. A number of cases have been reported by elevator superintendents in which dust which had settled on electric lamps became heated to the point of incandescence and fell from the globe into combustible material on the floor. It is claimed that fires have been started in mills and elevators in this way. Recent experiments have shown that under favorable conditions unprotected electric lamps may be the cause of a fire and dust explosion. At the Northwestern Elevator there was an unprotected electric lamp on a drop cord hanging in each garner above the driers. A conduit line ran across the top of the garners and the lamps were suspended from this line. These lights were used by the drier-men to determine the amount of grain in the garners. Since there was undoubtedly a large amount of dust in these garners while they were being filled with grain, it is assumed that considerable dust collected on the globes and the ignition of this dust from the heat of the lamp may be considered a possible cause of the explosion. However, since tests indicate that conditions must be favorable for ignition of dust in this way, this is not considered the most likely cause of the explosion.

8. *Broken Electric Lamp Globes.*—The ignition of dust by the breaking of an electric lamp was another theory advanced in connection with the investigation of the explosion. Experiments have shown that a dust cloud can be readily ignited by the breaking of an electric lamp. It is known that the workmen engaged in cleaning the garners over the driers were using extension lights or portable lamps on long cords. These cords were attached or plugged in one the bin floor of the work house and dropped over the edges of the garner bins to furnish light for the men working in these garners. In brushing down the sides of the garners considerable dust would be thrown into suspension and the swinging of an extension light against the steel sides of the garners would be sufficient to break the globe and cause ignition of the dust. It is assumed that the men cleaning the garners allowed the dust to pass through the grating at the bottom of the garner and from there through the drier into the spout leading to the boot of the drier leg in the work house. This is the point at which the first heavy explosion apparently occurred. Evidently no heavy explosion occurred in the drier garners since they are still intact and show very little evidence of fire. It may have been possible, however, to have the primary ignition

of dust due to the breaking of an electric lamp in the garner or in the drier beneath, and have the flames from this original ignition propagate through the spout to the point at which the explosion is supposed to have occurred. This may be considered a probable cause of the explosion.

9. *Fire in the Drier.*—Fire originating in the drier was suggested as a possible cause of the explosion. The drier had been in operation until about 4:30 p. m., one and one-half hours before the explosion occurred. During the hearings held in connection with the investigation of this explosion it was learned that there had been a fire in the drier the Saturday previous to the explosion, which was supposed to have been due to the ignition of dust which had settled on the steam coil. This fire was first discovered about 5 o'clock in the morning and was thought to have been extinguished at that time. However, it broke out again at 3 o'clock in the afternoon and it was necessary to run a hose line into the building to extinguish it. According to further testimony at the hearing, fires in the driers had been more or less frequent for some time previous to the explosion and it was assumed that this is one reason why this part of the plant was being given a thorough cleaning. Possibly dust which had lodged in the drier became ignited and during the cleaning was brushed or shaken from its lodging place and ignited the dust in suspension throughout the drier. The flames from this original ignition would propagate in the same manner described above through the spout leading from the drier to the boot of the drier leg in the basement of the work house.

Statements of Workmen.—Since all the employees in the elevator at the time of the explosion were killed it was impossible to obtain any statements which would assist in determining the cause of the explosion and the point at which it originated.

The watchman who was seriously injured in the explosion left the elevator a few minutes before the blast occurred and went to the office where he was preparing to eat lunch. He had been working for the Armour Grain Company for a year and nine months and stated that he came on duty at 4:00 p. m. the day of the explosion and pulled the first box at 5:15. He made his regular rounds, visiting the drier at 5:35 p. m., and returned to the office at 5:50 p. m. While in the drier, the point at which the explosion evidently originated, he did not see the workmen engaged in cleaning this section of the plant as at that time they were in the garners above the driers. He did not smell smoke or notice anything unusual during his trip around the plant. He stated, however, that there had been fires in the drier some time previous to the explosion.

CONCLUSION AS TO CAUSE OF THE EXPLOSION.

Due to the fact that all the employees in the elevator at the time of the explosion were killed, it is impossible to determine definitely the cause of the explosion. However, after a thorough investigation of the wrecked elevator and consideration of the statements made by grain company officials, elevator employees, eye witnesses and workmen employed at the elevator, or stationed nearby, it is believed that the explosion was caused by fire in one of the driers. The cleaning of the garners above the driers created the dust cloud through which the flame propagated to the basement of the work house where the first heavy explosion occurred. The breaking of an electric lamp used by the workmen cleaning the garners and driers appears to be a very probable cause of the explosion and should be given consideration. However, since there were no signs of an explosion in the garners, while the drier was completely destroyed, it is felt that the ignition of dust due to a fire in the drier is by far the most probable cause of the explosion. The fact that the drier was so com-

pletely destroyed would indicate that possibly there was an explosion with some violence in the drier before the flames propagated to the basement. The fact that the track shed and basement walls were forced out and the wreckage of the drier dropped to a point almost below its original position would indicate that if there was an explosion in the drier previous to the explosion in the basement it was not sufficiently violent to blow the drier from its original position.

LESSONS FROM THE EXPLOSION.

A number of lessons can be learned from a thorough investigation of this explosion. Many of the previous recommendations made by the Bureau of Chemistry for the prevention of dust explosions have been borne out in this case. The fact that "fireproof mills and elevators" are not explosion proof has again been clearly demonstrated. The fact that the storage section of the elevator and river house, where the storage bins were not covered, was heavily damaged while the work house in which the bins were floored over was damaged less than any other section of the elevator proper, would indicate that as previously suggested, all bins should be floored over, and a vent to the outside air provided for each bin. There should be no communication whatever between bins.

The greatest violence and damage was at the extreme point from where the explosion originated. This indicated very definitely the presence of sufficient dust to propagate the flame from the primary explosion, thereby developing excessive pressure resulting in a secondary explosion of large proportions. The Bureau of Mines as a result of the investigation of a large number of disastrous coal mine explosions and special tests in the experimental mine and galleries near Pittsburgh, Pa., report that in a dust explosion the greatest destruction and violence is evident at points considerable distances from where the explosion started. This was well demonstrated in this particular explosion.

No vapor-proof globes were used on the electric lamps in the elevator with the exception of the signal lights, and a number of the lights were unguarded. Due to the fact that it has been clearly demonstrated that explosions and fires can be started by the breaking of an electric lamp in a dusty atmosphere or by the ignition of dust which has settled on the globes, elevator companies should follow out the previously made recommendation that all electric lamps be protected by vapor-proof globes and properly guarded.

The explosion at the Northwestern Elevator demonstrated the value of light wall construction. The cupola walls constructed of gunite or concrete sprayed onto metal lath or wire mesh were readily blown off by the explosion and little damage was done to the equipment in the cupola of the work house. The walls on the cupola of the river house were constructed of the same material but the great damage in this section of the plant was probably due to the explosions in the open bins below and to the explosion in the storage section which threw debris against the river house. The tremendous violence evidenced in the basement of the storage section of the elevator bears out the recommendation made by the Bureau in connection with the investigation of an explosion in the Southwest, that grain elevators be constructed without a basement and with light walls or curtain doors to prevent the building up of excessive pressure underneath the bins in case an explosion occurs.*

The use of extension lights or portable lamps on long cords has long been considered a hazard in dusty industries because of the many possibilities of forming

*Proceedings Grain Dust Explosion Prevention Conference, July, 1920.

sparks due to short circuits when the insulation is worn by dragging the cord along the concrete floor, or over the sharp edges of bins and girders. The elimination of the need for extension lights by the development of a special system of lighting for mills and elevators is a problem which is now being given consideration by the electric lamp companies. While the use of extension lights may not have been the direct cause of this explosion, it is considered a very likely one, and of sufficient importance to demand immediate consideration.

This explosion again shows the need for a revision of the rules governing the application of suction to grain streams. Suction should be provided to collect the dust at every point where the grain is thrown or handled. Present rules prohibit the application of suction in any form to the grain before it is weighed. These rules make it necessary for the elevator operator to receive into his house all dust and dirt shipped with the grain. These regulations were designed to protect the shipper by preventing the removal of dust, or possibly a quantity of grain which would reduce the weight of his shipment and consequently the amount received from the sale of his product. Some provision must be made which will permit the elevator operator to remove the large quantity of dust which he receives with the grain and which constitutes the menace to life and property, and at the same time protect the shipper by preventing the application of suction strong enough to remove any grain. Some provision should also be made to reimburse the shipper for the dust removed, which has a certain value for cattle feed.

My feeling is, that this is the crux of the situation. Control has been made in the prevention of dust explosions in flour mills, starch mills and kindred industries. We all know the flour milling industry paid the toll following the explosion in Minneapolis and introduced improved methods of dust collecting systems. It is not very difficult to prevent an explosion unless some difficulty is experienced in controlling the material which is going to explode, and the true facts are these,—no grain elevator operator in this country or Canada or anywhere at the present time can do anything with the dust until after the grain is weighed. Those regulations were not made with the dust explosion danger in mind. They were made, and well made, to prevent any abuses that might occur and to maintain the constant weights between the shipper and the receiver. But in recent years a new factor has been injected into the matter. We now find we are having disastrous dust explosions in our large terminal elevators, those explosions are occurring in plants where the operators are probably following all known methods of prevention, but are compelled to remove dust that has settled in the plant by the ordinary push broom method of handling. It will be a physical impossibility to expect a plant of this kind to be kept clean by ordinary hand methods or by a floor sweep system.

The damage caused in the basement of the storage section by this explosion teaches another lesson of special interest to elevator engineers. Evidently the height of the basement, especially the part above ground, was insufficient to permit the release of pressure produced under the storage bins by the explosion. In other words the pressure under the bins was built up faster than it could be relieved through the openings at the side of the house.

RECOMMENDATIONS.

The investigation of this explosion shows that many of the recommendations previously made by this Bureau in its dust explosion prevention work have been substantiated.

December, 1921

This walls on heavy frame work have been previously recommended for elevator construction. The fact that in the explosion at the Northwestern Elevator the thin walls of the work house cupola were blown off without doing as much damage to the equipment as in other sections where heavier walls were used would indicate that the light thin wall is preferable wherever it is possible to use this type of construction.

For some time this Bureau has been recommending aspiration or the application of suction during the handling of grain in order to remove the dust before it has had an opportunity to escape and accumulate in the elevator. Rules and regulations now enforced by certain bodies prohibit the application of suction before the grain is weighed. This makes it necessary to receive the grain and dust into the house, elevate and weigh it before any aspiration is permitted. During this handling of the grain a large amount of the dust escapes and in a plant the size of the Northwestern Elevator, where enormous quantities of grain are handled in a short time, this dust accumulates so fast that it is almost impossible to keep the elevator clean by ordinary methods of brushing and sweeping.

Another recommendation made by this Bureau has been that all storage bins be covered, vented to the outside of the building, and have no direct communication between each other. The fact that in the Northwestern Elevator explosion the work house in which the storage bins were covered was damaged less than any other section of the plant, while a number of the bins in the storage section which were not covered were completely destroyed, would indicate that his recommendation should again be brought to the attention of the elevator construction engineers. Vents should be provided on all elevator heads to permit the release of any pressure built up within the lofter legs, should an explosion occur. In many cases the explosion propagates from floor to floor through these openings. In one case where considerable trouble was experienced with explosions during the elevating process it has been necessary to vent the leg at each floor. It has been previously recommended that all ledges or surfaces where dust may accumulate in the building be enclosed or bevelled at such an angle that it will be impossible for dust to accumulate on them. The fact that the framework over the storage bins was of structural stel with many exposed places where dust might lodge, permitted large accumulations at this point which it was impossible to remove without employing a large force of sweepers.

Previous recommendations have been made for the protection of all electric lamps in dusty atmospheres by the use of vapor-globes and heavy guards. The fact that one of the signal lights in the track shed, the only lights protected by vapor-proof globes at the Northwestern Elevator, was blown out with the frame work of the track shed and still remains unbroken, indicates the degree of protection afforded by this type of equipment. Other lamps were used throughout the plant without even the protection of a light wire guard. Since tests have shown that explosions can be started by the breaking of an electric lamp in a dusty atmosphere, or the ignition of dust which has settled on the lamp globe, steps should be taken to see that all equipment of this kind in dusty industries is sufficiently protected.*

It has been previously recommended that instead of one large dust collecting system several separate installations be used for the removal of dust from large plants of this kind. At the Northwestern Elevator a large dust settling chamber with cyclones was installed between the work house and the storage section. The complete destruction of this equipment would indicate that in future installations the

*U. S. Department of Agriculture. Circular No. 171.

settling chambers and collectors should be located some distance from the main plant or at least on one side and not between buildings. Good housekeeping is essential for the prevention of disastrous dust explosions. Too much emphasis cannot be placed on the necessity for removing all dust from the house as soon as possible.

DISCUSSION.

J. V. SCHAEFFER,* M. W. S. E.: I have been very much interested in listening to this paper, and I wonder if it may not well be that the reading of this paper here before the Western Society of Engineers will mark an epoch in the designing and construction of grain elevators. It seems to me, Mr. Price has brought to our attention the difficulty and it remains for the ingenuity of American engineers to meet that difficulty and solve the problem, and as heretofore engineers have always shown themselves capable of meeting these problems, I believe they will do it in this case.

My only connection with this elevator was in building the Gunite walls, which encased the workhouse, the unloading shed and the river house. The walls of this building were constructed by erecting steel framework, using vertical beams wherever possible. It was very carefully looked into and the effort was carried throughout to avoid so far as possible having any horizontal members on which dust might lodge, so that, with the exception of a few window sills and lintels, practically every member in the building on which we put Gunite walls was of vertical section.

Our Gunite walls were built of American steel and wire triangular mesh, which was put on in horizontal belts or bands, each ribbon of wire mesh being, as I remember it, something like four or five feet wide. The wire mesh was attached to the steel beams by means of ordinary spring lock washers. We have found that the simplest method of attaching a wire mesh to a structural beam is by simple spring lock washer. You can set one of these on the edge of a beam and by striking it with a hammer it will spring enough to drive on, and by hooking it around the wire mesh and driving it on the beam it is locked on the beam, and as it drives on the sharp points where the wire has been broken, cuts a groove in the beam so it binds on there so tightly that you can hardly pull it off with a claw hammer. As the wire mesh was stretched across these beams sometimes the flange was parallel to the section of the wire mesh and sometimes it was perpendicular to it, but in all cases we used this lock washer, and drove one of these on, I suppose, about every eight inches, and that was what held the wall to the steel structure. It was held on there sufficiently strong to resist any wind pressure that might be expected. I drove out to the elevator about the second day after the explosion and I was very much interested in observing what happened to these walls. I found that large sections of the walls from the work house easily 20 feet square had blown out intact, were blown, I would say, 300 yards away. I would judge that the wall gave way very readily; and I don't believe that the explosion was intensified by being confined by walls which wouldn't readily give way. The washers seemed in some cases to have pulled off where the flange was perpendicclar, where it had nothing but the gripping effect, and where the flange was the other way and it had to shear it off, it had actually sometimes sprung the washer, and in many cases sheared it right off, so the attachment of the wall to the girder was the strength of the iron, or the steel, split washer.

J. B. WILSON: I notice several previous fires, and no explanation of them. Can you tell us what effect they might have had? I would like to know

*President, Cement Gun Construction Company, Chicago.

also if there was any investigation of the temperatures used in the drying of that grain.

D. J. PRICE: These fires referred to were supposedly dust fires in the drier, not fires that occurred while the drying operations were going on, supposedly from,—we will say,—the dust settling on steam coils,—I think I referred to that in one part of the paper. Now I know that is going to get a "rise" out of the heating engineers right off the bat, just the same as we got a rise out of the electrical engineers when we said you could get a fire from dust on the globe. But the facts are there were dust fires in those driers, and of course you are all familiar with the arrangement of a drier, so you can draw your own conclusions as to how those fires started.

T. L. CONDRON,* M. W. S. E.: I wanted to ask a question of Mr. Englar. I have understood that not only did the bins go up, but that the foundation slab went down as a result of this explosion. That would be an interesting illustration of the efficiency of piling, and I would like to know if it has been possible to determine yet whether the foundation slab was displaced from its original position as a result of the explosion, and if so, to what extent?

W. C. ENGLAR:** That has been determined. The foundation slab has all been cleaned off and readings have been taken and there hasn't been any damage done to that. There was no settlement to any foundation slab.

F. J. POSTLE,† M. W. S. E.: It is my understanding that the small cleaning systems at receiving stations are coming into more and more general use. The thought occurs to me that possibly if the regulations were more strictly enforced as to cleaning stations, the fact that the grain is sampled on dust as well as it is on classification as to what grade it goes into, that that might be a means of reducing the hazard, at least. Of course there will always be dust and there will always be an electrical hazard, and there will always be a steam pipe hazard, the problem is in merely reducing it to a minimum.

At the small mills and elevators taking the grain from the farmer I think they are more and more coming to the idea of cleaning the grain as it is received. I know of installations of that kind where when a farmer comes in with a wagon load of wheat, the wheat is dumped, it goes through the cleaning machine while his wagon stands there, and the dust, and that, of course includes the fine grain and chaff, etc., is drawn right off and put back into the bags and put into his wagon, so the mill only buys the net wheat and not the gross.

I would like to ask Mr. Price as to how far that is being carried out, or whether that wouldn't reduce the hazard?

D. J. PRICE: Well, if that could be applied to every point where the grain is handled, it would reduce the hazard; but the commercial situation is something like this: We will start from the farm with the grain. The Department of Agriculture the last few years has been investigating a series of explosions in the Northwest that occurred during the threshing of the wheat crop in the inter-mountain country between the Cascades and the Rockies. There have been as high as five hundred explosions in six weeks in those threshing machines. They have oc-

*Condron Company, Chicago.
**Secretary-Treasurer, Wilkerspoon-Englar Company, Chicago.
†Consulting Engineer, Chicago.

curred at periods of low humidity, with high temperature, with a great deal of smut in the grain, or diseased wheat. The smut dust is very explosive.

One of the effective control methods that have been developed has been the installation of fans on the deck of the threshing machine to draw from the cylinder the dust or weaken the volume so that when the static spark, which is the principal cause in this case, is present, the explosion hazard is not so great. In other words, the application of a fan for dust control decreases the explosion hazard.

If that were possible on the threshing machine, it ought to be possible at the country elevator. It ought to go even further; it ought to go to the terminal elevator, it ought to go to the elevator on the seaboard. It is perfectly true that when grain gets to Baltimore and Montreal and Buffalo and Boston it has the dust all the way from the Pacific coast and when you talk aspiration they will hold up their hands and say, "Why the weights are so vitally affected we cannot consider it." But if there was a possible way to apply aspiration at every point where the grain is handled and at every point in the elevator where the grain is handled, we could probably curtail the dust hazard. There is not any operator of any elevator in this country or Canada or anywhere else could do it if he wanted to apply aspiration from the time the grain reached the elevator until it is weighed,—it must be first weighed. Now then, when the grain is dumped and goes to the boot and up the leg and on the belt into the bin you have considerable dust, and if we didn't do anything further with aspiration for the time being but collect that dust that escapes and gets out and settles on the beams and girders, we would at least accomplish something, and that is what I meant by the statement that we have to do more in engineering science than we have done up to the present time.

CHAIRMAN CHAS. H. MCDOWELL,* President W. S. E.: I might say in the grinding of organic matter, such as bones, tankage and materials of that kind an explosive dust is stirred up. It is a general practice to have very light pent houses around the mills and over them, the screens, and to have windows hinged, of a very light construction, so if there is any flash or any flame, that the release is given quickly. Since those have been installed in certain plants there has been no fires.

*President Armour Fertilizer Company, Chicago.

CALUMET STATION OF THE COMMONWEALTH EDISON CO.

A. D. BAILEY,* M. W. S. E.

Presented April 18, 1921.

SYNOPSIS.

Calumet Station, now under construction, is located on the west bank of the Calumet River at 100th street. Although the ultimate station lay-out contemplates a capacity of 180,000 K. W. the present installation consists of one 30-000 K. W. Westinghouse Tandem compound unit and one 30,000 K. W., General Electric unit, the former equipped with Westinghouse condensing equipment and the latter with Worthington equipment. The boiler installation will consist of seven 1,500 H. P. Babcock & Wilcox boilers fired with forced draft chain grate stokers, and augmented with superheaters and steel tube economizers.

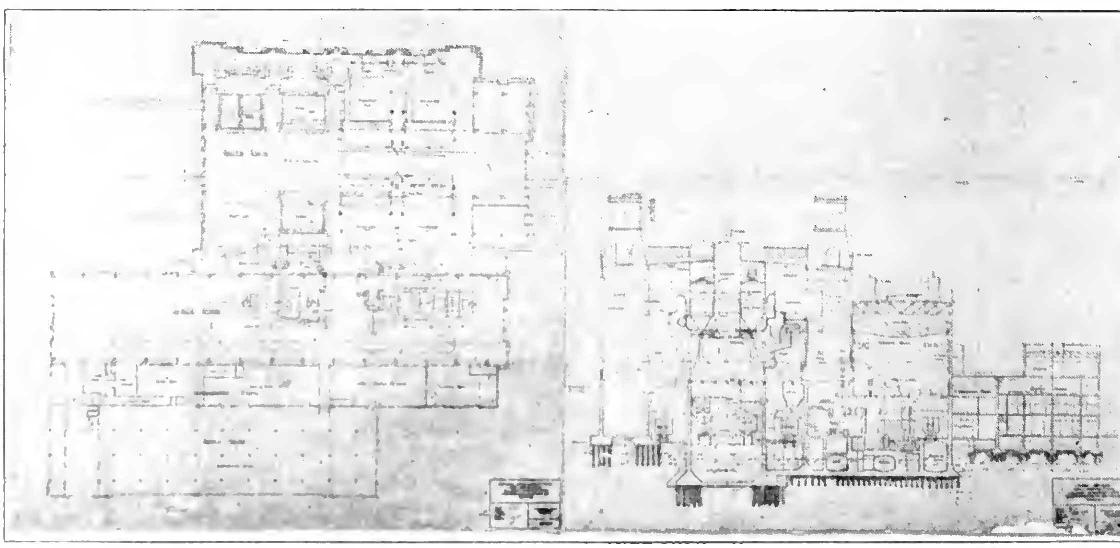


FIG. 1.—At the left is a general plan of Calumet Station, now under construction, showing switch house, transformer house, turbine room and boiler room divisions. The complete plan contemplates six turbines and 21 boilers. Two turbines are to be installed at this time. At the right is shown the sectional elevation of Calumet Station. The train shed and coal receiving pits are located directly below the boiler room floor, coal being handled onto a belt conveyor running parallel to the cars and discharging at the east end into a coal breaker for sizing. From this point bucket elevators carry the coal to the top of the building and it is distributed to bunkers above the boilers by belt conveyors running lengthwise of the boiler room.

The ash pits are located on both sides of the train-shed and are provided with tracks at approximately train-shed level, so that the ashes can be dumped directly into the cars without any intermediate handling. The forced draft fans are located immediately back of the boilers and the induced draft fans taking the flue gas from the economizers to the stacks are located on either side of the boiler house above the boilers.

The turbine room elevation shows the location of the turbines and the track running lengthwise of the room from which machinery is handled, also the in-let and discharge tunnels for circulating water for the condensers. In the intermediate section to the right will be located not only the transformers for the out-going tie lines but also transformers for the auxiliary machinery about the station. This section of the building will also contain a machine shop, store rooms, etc., which are immediately adjacent to the turbine room. At the extreme right is the high tension switch-house.

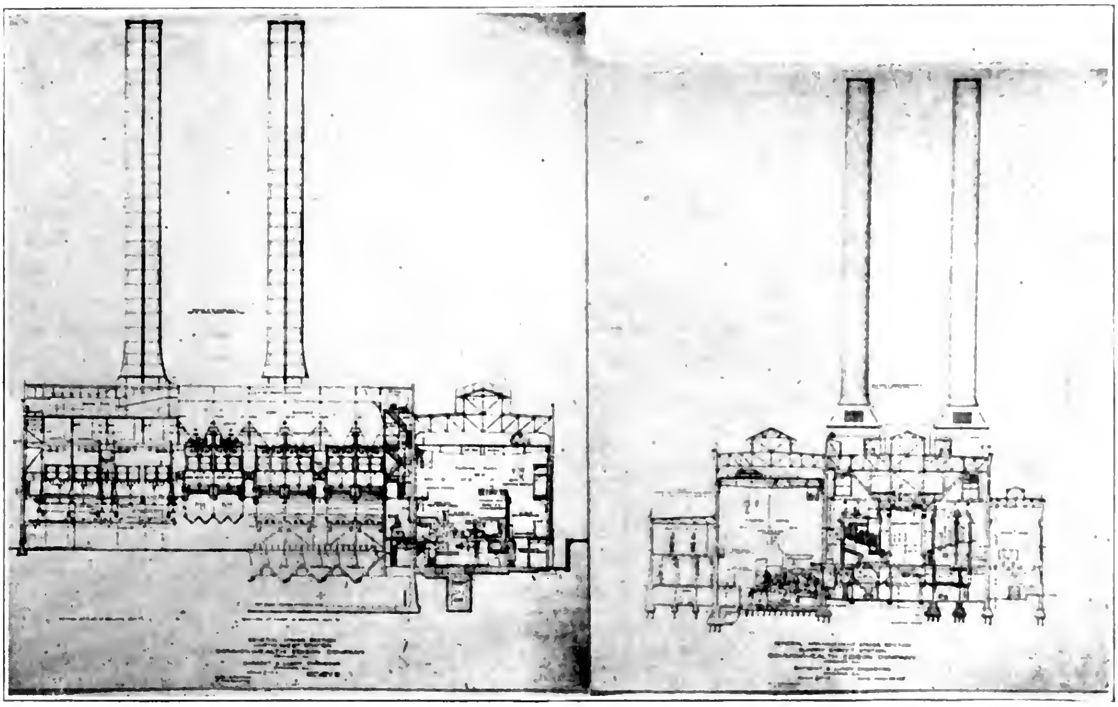
On account of the fact that the Calumet River flows in either direction, due to the wind or changes in lake levels, the circulating water tunnel lay-out is novel in that a long flume extends along the river front so arranged that the circulating water can be taken from either end and discharged at the other. The intake tunnel will be provided with revolving screens for removing the suspended matter in the circulating water.

*Superintendent of Stations, Commonwealth Edison Co., Chicago.

The coal unloading shed will be located directly below the boiler room, the coal being handled in the usual manner, with bucket elevators and belt conveyors. A new feature of this installation is a Bradford Breaker for sizing the coal. The ashes from the pits below the stokers will be dropped directly into railroad cars without any intermediate handling.

In the switch-house the bus arrangement is novel in that the "A" phases of all buses will be located at one side of the house, the "B" phases in the center and the "C" phases at the other side.

The power for the auxiliaries, most of which are motor driven, will be supplied at 2,300 volts for the large motors and 400 volts for the smaller, the power being taken from the station buses through transformers. Although the generating



Northwest Station **Quarry Street Station**

FIG 2.

pressure is 12,000 volts, step-up transformers to 33,000 volts will be provided for tie lines connecting this station and Fisk Street Station.

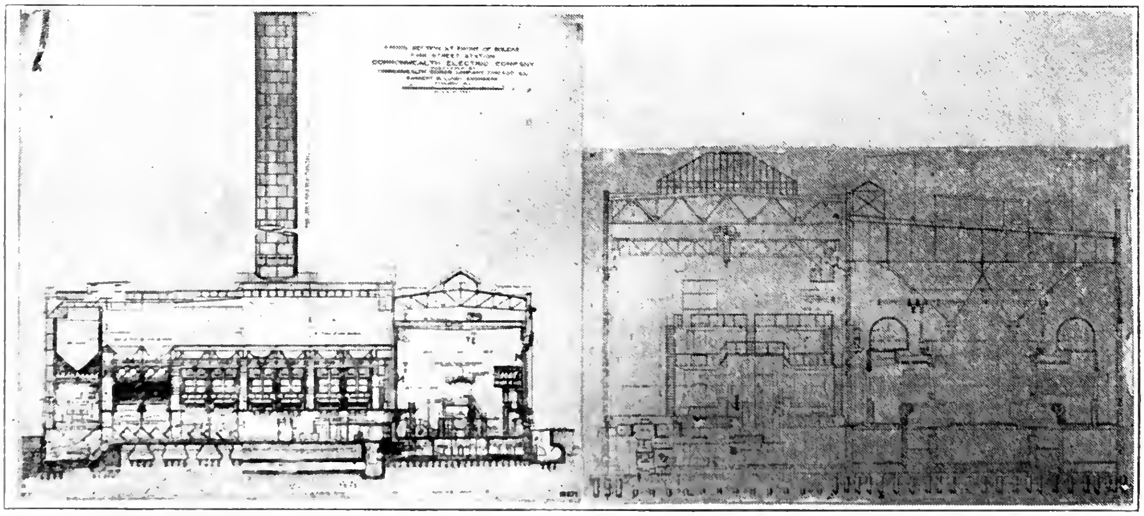
Calumet Station is going to be for the time being a 60,000 kilowatt plant. Ordinarily 60,000 kilowatts, 90,000 horse power sounds like a big installation, but when you tack it on to a system of some 500,000 kilowatts it isn't of so much significance. Calumet in itself has some new features which we haven't in the other stations. Some of the good features of Fisk Street and of Quarry Street and Northwest Stations will be embodied in Calumet, with additional good features which can be added on account of the time element and on account of the increase in size of the units.

GENERAL.

We already have a plant at the northwest corner of town, Fisk Street and Quarry Streets correspond, in a way, to a central location, and this new plant will take care of the southeast end of town. The ground area comprises some

forty-three acres, and compared with Harrison Street, which was a first-class station some twenty-five years ago, you wonder why we need so much ground. The answer is coal.. We have got to have space to keep on hand a large supply of coal, not only in cars, but on the ground, for use in case our supply is cut off.

Calumet Station will be connected with the present system by two tie lines to Fisk Street, 33,000 volt pressure. These tie lines will have a load capacity of approximately 30,000 kilowatts, there being step-up transformers at each end for changing the pressure from 12,000 to 33,000 volts.



Fisk Street Station Harrison Street Station

FIG 3.

The physical arrangement of the building will be similar to other Commonwealth Edison plants, including the boiler house, turbine room and electrical distribution room or switch-house, the transformer house in this case being located between the turbine room and the switch-house. The building as now under construction will be 217 feet long, 285 feet wide and 100 feet high. Ultimately it will be 495 feet long in the turbine room, 570 feet long in the boiler room, and 285 feet wide and 100 feet high. The outside finish of the building will be brick, the inside enamel brick similar to the present plants.

The area of the boiler house and coal handling equipment is 65 per cent of the total building area. This is continually being increased in each station as we go along. The coal is playing a more and more important part in every new development.

The stacks will be 16 feet inside diameter, 167 feet above the grates. There will be four 1,500 horse power boilers per unit and four on each stack. The boilers will have 4,000 feet of superheating surface and a combustion chamber volume of 6,700 feet; the boilers themselves will set about sixteen feet above the grates, the idea being to get a large combustion space so that we can burn a lot of coal on the grates, complete the combustion below the boiler, and not only complete combustion, but at the same time eliminate smoke.

The boilers will be of the Alert type,—the cross drum B. & W., type boiler with twenty-foot tubes, four inches in diameter, and will be built for 350 pounds pressure. The boilers are designed, the boiler itself and furnaces, to evaporate

150,000 pounds of water per hour, which will be something over 300 per cent of normal rating. This, of course, is largely a matter of stoker equipment and furnace design. The stokers will be forced draft chain grates, six of them already on order, of the Coxe type. That is a stoker which was developed in the East for anthracite coal and was probably the earliest type of forced draft chain grate.

In that connection it might be well to say to those of you who are acquainted with chain grates that in going over some boiler statistics a short time ago, I found that the first chain grate was built way back in 1848. We had most of us, I think, imagined that the chain grate was a rather new development, but a man by the name of Juckes built a chain grate that is very similar to the natural draft chain grates now in use back in '48.

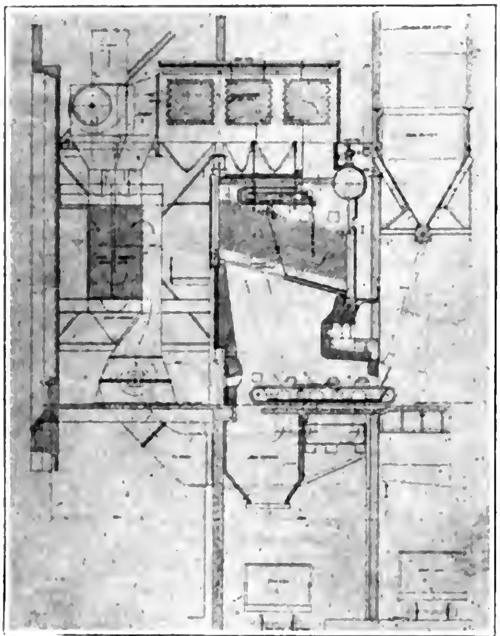


FIG. 4.—Elevation of Boiler Setting.

The blast for the stokers will be provided by forced draft fans, two to each boiler, each having a capacity of some 50,000 feet of air per minute, and the induced draft fans, one to each boiler, taking the flue gas to the stacks will be driven by 200 horse power motors. That will give you some idea of the size of the equipment.

The economizers, instead of being cast iron or semi-steel, as we have now installed, will be manufactured by the B. & W. Co., and will be made of steel tubes and steel headers. This is necessary on account of the pressure. These will have a surface of some 9,600 feet per economizer and there will be one economizer for each boiler.

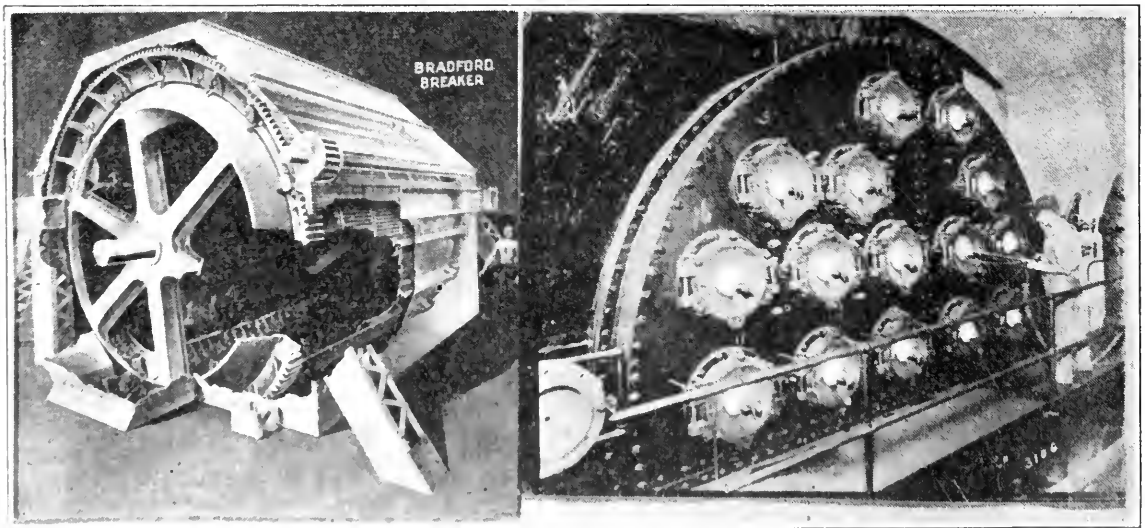
We have made a departure also in the preparation of the coal. Whereas we have formerly used roll crushers, we are making a radical change in going to a Bradford Breaker. This breaker is nothing more nor less than a large steel cylinder, some twelve feet in diameter, and fourteen feet long. It revolves very slowly. The coal is fed inside the cylinder at one end and is carried up by the revolution of the cylinder and is dropped as it reaches the top. It strikes the bottom of the cylinder and is broken up and discharged through holes in the shell of the cylinder, so it is absolutely necessary for the coal to be broken up before it can pass through into the coal handling equipment. Those who have had to do with chain grates probably realize the importance of properly sizing the coal. If it is not properly sized it is not properly burned, and is dumped off the back end of the grate with a considerable portion of its carbon content remaining. The elevating conveyors will be made by the Mead-Morrison Company, and the belts by the Robbins Conveying Belt Company.

The steam leads from the boilers will be duplicate as in our present arrangement, two seven-inch leads per boiler feeding an eighteen-inch header into a separator, and from that into the turbine.

The turbines in detail are, first a Westinghouse tandem compound machine, 1,200 r. p. m., 30,000 kilowatt, at 85 per cent power factor, and the General Electric an 1,800 r. p. m. machine with the same size generator, 30,000 gilowatts at 85 per cent power factor.

The condensers will be first a Westinghouse, and for the second unit a Worthington, each having some 52,000 square feet of cooling surface and supplied by pumps with a capacity of 55,000 gallons per minute. The circulating pumps as well as the auxiliary pumps, for this equipment, will all be motor driven. For heating the feed water we will bleed the main turbine; that is, take steam from the lower stages of the main turbine in order to get the requisite temperature for putting the water into the economizers.

Those who have burned Illinois coals know how much trouble there is with sulphur. The coal contains four or five per cent of sulphur and as a result we find the railroad cars, railroad equipment of all kinds, and the power house equipment



Left—Bradford Breaker. Right—Condenser Washer Cleaning During Operation.
FIG. 5.

being continually eaten. It has been estimated that steel cars will last about six years, conveyors handling coal and ash will last about seven, and in no place is the action of this sulphur more marked than in the economizers, where they get the direct action of the flue gas at comparatively low temperatures. Under certain conditions it is necessary to renew these economizers every second year. One can appreciate how this action takes place by assuming that the economizer is merely a condenser for the sulphuric acid or the sulphurous acid in the flue gas. If the water is put in at 90 degrees, as we started to do, there's a heavy deposit of soot loaded with sulphurous acid all the way through the economizer. By increasing that initial temperature of the water the condensation of acid is retarded in the soot on the tubes, and it is the plan to put the water into the economizers at about 175 degrees. At the present time we are using a temperature of about 140 degrees. Thermodynamically there is an advantage in putting the water in as cold as possible, the idea being to reduce the uptake temperature of the flue gases by so doing, but physically it is not a good proposition; financially it is not a good proposition either.

Practically the only steam driven auxiliaries will be the boiler feed pumps; three of the four will be turbine driven. Also one of the auxiliaries on each turbine will be turbine driven.

On the electrical end of it, the power for operating the switches will be 230 volt D. C. supplied from transformers and the motor generator set within the station; the power for the auxiliary motors above fifty horse power will be 2,300 volts,

sixty cycle A. C. This is something new for us, although there are stations in the East which are running their auxiliaries with this high voltage.

The smaller motors will be 440 volts A. C., sixty cycle.

CHAIRMAN: Will Mr. Douglas tell us about the General Electric unit.

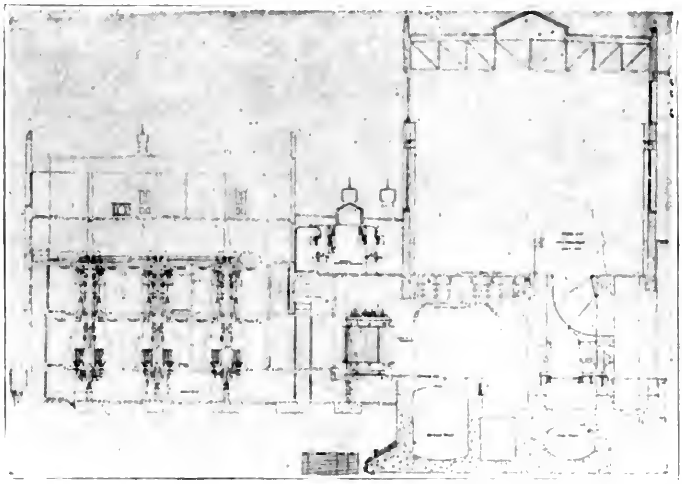


FIG. 6.—The switch-house arrangement. The "A" phases of the buses are grouped ot one side, the "B" phases in the center and the "C" phases at the other side.

C. C. DOUGLAS,* M. W. S. E.: I don't know what you might be interested in in reference to the unit. It is a 17 stage single impulse unit with the best point of economy at about three-quarters load. It has steam admitted all the way around the rotor of the first wheel; it has the primary and secondary admission valves. The unit, of course, is laid out for the high temperature steam that we will get here and great care should be taken in these units to provide for the expansion and contraction that takes place in operating under such a condition.

J. B. WILSON,** M. W. S. E.: I don't know as I have anything to say except that I understand the expansion joint between the turbine and condenser is rubber; you might be interested in that. The turbine is very similar to the one at Northwest. The boilers are built for 350 pounds and 250 degrees of superheat. We will have 300 pounds at the turbine and approximately 250 degrees and one inch back pressure.

F. R. WHEELER,† M. W. S. E.: What is the thermal Rankine efficiency on that? What is the estimater efficiency of the plant?

A. D. BAILEY: The estimated efficiency of the plant should be a little better than the new machines at Fisk or Northwest, which will mean about 19,000 B. T. U. to the kilowatt, which would be, I think, between 18 and 19 per cent.

J. B. WILSON: I would like to ask Mr. Schuchardt about the arrangement of the busses.

R. R. SCHUCHARDT,†† M. W. S. E.: I suppose Mr. Wilson refers to the one feature of the transmission, which is quite different fro manything heretofore used in generating stations, and that lies in an arrangement of the three phases. Instead of being adjacent to each other, that is, the three phases adjacent to each other, the two similar phases, or rather, the similar phases of the two busses are together, the phase themselves being separated very widely, that is, from crosswise of the switch-house instead of the order of the phases being a, b, c of on bus, one side starts out with the A of one bus and the A of the second bus, in the middle the B of the two busses and on the other side the C phase. In that way the phases are so far separated that the chance of crosses between phases is very much eliminated. The transformers that Mr. Bailey says he is somewhat afraid of are in the end of the station, but the part which he did emphasize is that most of those transformers

*Commercial Engineer, General Electric Company, Chicago.
**Resident Engineer, Westinghouse Electric Company, Chicago.
†District Manager, C. H. Wheeler Manufacturing Company, Chicago.
††Electrical Engineer, Commonwealth Edison Company, Chicago.

are for the electrical drive of the station, they are the very important part of the station, of course, the 33,000 volt transformer being merely incidental. That 33,000 connection, —the tie between Calumet and Fisk—is the highest voltage ever carried in an underground cable in America; it is the first case of anything higher than 26,000, 27,000 or 28,000 volts being used for transmission in a cable.

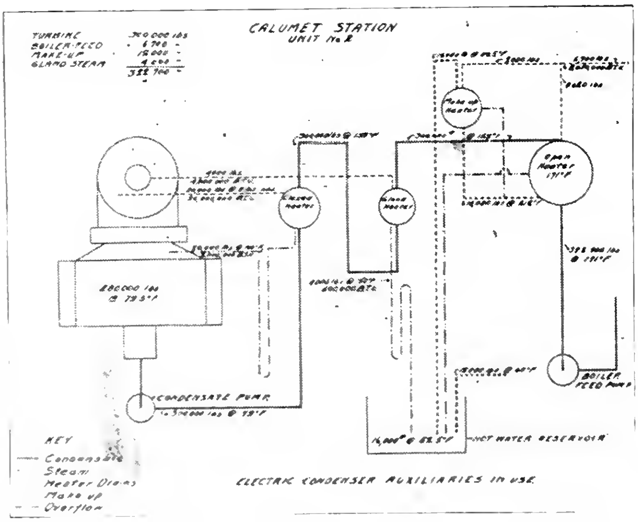


FIG. 7.—The condensate from the condenser is first heated in a closed heater by steam bled from the main turbine below atmospheric pressure; then by the exhaust steam from the high pressure packing gland, and lastly by the steam from the auxiliaries. In this manner the temperature of the boiler feed will be raised to approximately 170 degrees before it enters the economizer, which should practically eliminate troubles from corrosion at this location.

QUESTION: What provision is made for an auxiliary supply for the electrically driven auxiliaries?

MR. R. F. SCHUCHARDT: The connection is made from the busses, from the main bus to the station through reactors; that is, a double reactor, there is a two section series tieing the two busses together, and the middle point, as a joint between the two reactors, is the tap for the power transformers. The capacity, of course, is ample.

MR. WILSON: Why do you put a separator in there when you didn't believe in them?

MR. BAILEY: I didn't say we don't believe in them. I suppose we put a separator in because Mr. Wilson and Mr. Douglas thought that a separator would be a fine thing if it would stop water from going into a high speed turbine. There is no question but what these steam turbines will not run on hot water. On the other hand, it must be borne in mind that the separators as installed will not take care of great slugs of water. The steam is traveling altogether too fast. The steam in the headers is traveling at the rate of 10,000 feet, and the water going along with it is going pretty near as fast; it would take an unreasonably large separator to hold out any considerable amount of water. It may, however, be the means of saving a turbine. You probably can realize what will happen to a set of blades traveling 40,000 feet a minute with nice, compressible steam operating on them, at a high temperature, to very suddenly get a dash of a considerable quantity of comparatively cool, non-compressible water. It is very apt to take the blades off, and to set up vibrations. Further than that, it sets up strains in the metal, due to the sudden change in temperature, which is apt to be exceedingly disastrous. Sudden changes in temperature must be guarded against everywhere in the operation of these large turbines. The turbine men all feel relieved when they get these things up to speed and get them running, and they say to the operating man, "Now it is running fine, it is yours." Then they stand off and wonder whether you are going to have nerve enough to shut it down. That is why we are spending money putting in condenser washers to wash them while they run. But it is a fact you must avoid sudden changes in temperature. We take an hour or more to bring those machines up, increasing the load on them very gradually. We have to baby them along as compared with the old vertical machines which we shot up and down, and which we

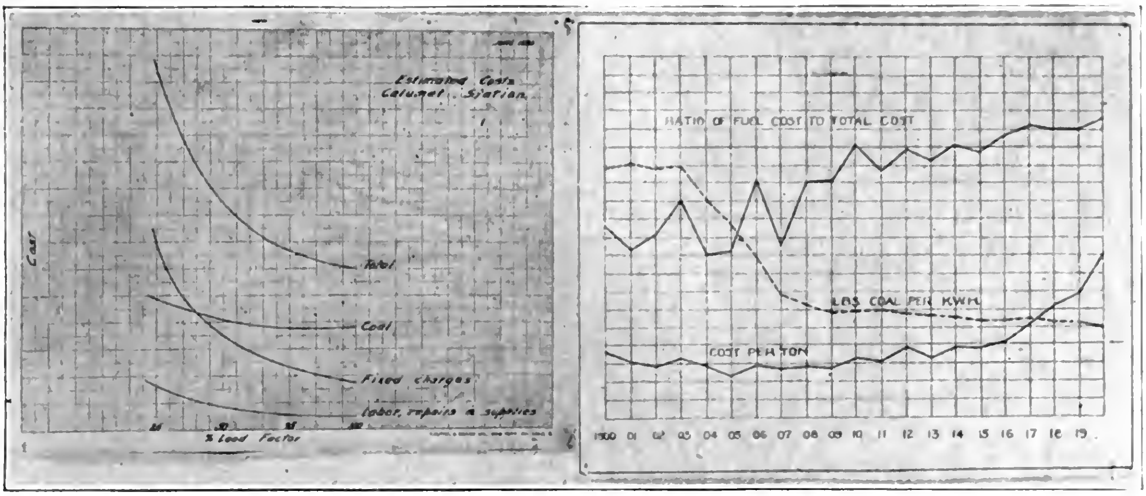


FIG. 8.—Left—Shows operating costs varying with the load factor. Right—Showing the increasing importance of full cost in relation to total generating cost over a period of 20 years. This in spite of the decrease in amount of coal per unit of output.

still shoot up and down without stopping to consider just what inward pains or distortions they are undergoing. They have plenty of clearance, and if they haven't enough they will rub a little off and have enough. But these new machines don't act that way. To keep up their high efficiency, they must be handled very carefully.

MR. DOUGLAS: Have you anything on air washers on these machines?

MR. BAILEY: The air circulation on these generators is a closed system. It is a carrier system, a closed circuit, the air operating continuously from the generator into the washer and back into the generator instead of drawing in a continuous fresh supply as with the present equipment. We have no water softeners at all. It is probable that we will put in evaporators to take out the scale and the mud. We should have better water after the canal is cut through and we get a positive circulation in the river, but even under the present conditions, we should get pure water if we have a good evaporating system.

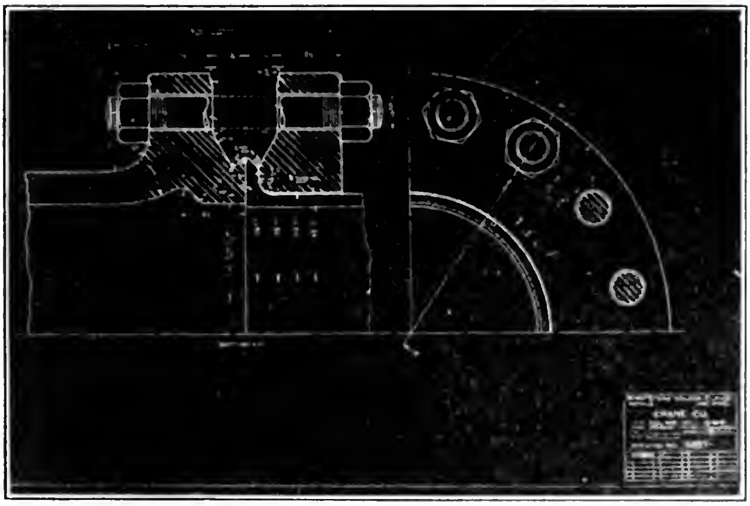


FIG. 9.—Shows a joint in steam header. These are made with the flange fairly loose on the pipe but with the pipe faced over the flange where the joint is to be made. The faces making the joint are carefully machined and the edges are scraped and welded at the tip after the pipe is made up. No gaskets are used.

QUESTION: Is any provision made for screening the intake water?

MR. BAILEY: Yes, at the intakes we will have a double set of revolving screen passing over pulleys above and below the water, affording a double screening surface. In addition there will be two sets of these screens, whereas in the present installations we have one set of revolving screens and a double set of stationary screens. The object of this is, to cut down the hand labor required for the stationary screens.

THE USE OF STEEL BANDS FOR POWER TRANSMITTING AND CONVEYING PURPOSES

By Bernard Kruger*

The entering of metal bands into competition with ropes, leather and textile belts for the transmitting of power and the mechanical handling of material, has made great headway during the past few years in Europe. As very little concerning this development has appeared in the literature of this country, I believe a fuller description is sure to be of interest to the members of this Society.

At the present time there is towards one million horsepower being transmitted by steel bands covering every class of drive, and over 1,000 steel band conveyors at work handling not only ordinary materials but including some hitherto impossible for any kind of belt conveyor.

The successful use of steel bands for power and conveying has been gradually evolved from experiments made during a period of nearly fifteen years in most countries where mechanical power is used. The early experimental attempts were directed to the use of steel bands for power transmitting but after a short period of use they invariably broke when subjected to any considerable increase in load.

Persistent failure also attached itself to the various connections used in joining the ends of the bands together. Subsequent experiments showed that these unsatisfactory results were attributable mainly to mistaken conceptions as to the conditions under which steel bands should be used. In calculating and constructing metal band gearing on the occasion of previous experiments it was found that consideration was not given to the fact that the metal band employed is subjected to a flexure constantly varying from zero to a maximum, and that to insure durability with such a demand it was not sufficient for the bands to be calculated in the usual manner, that is, so that the greatest bending stress which occurred was below the limit of fracture of the material. The error consisted in not regarding the result of philosophical researches first undertaken by Wohler, according to which a tension constantly varying from zero value to a maximum and frequently applied to a body causes self-destruction, if the maximum tension is not confined to half the breaking stress of the material.

The present system is therefore based on the knowledge that a fracture of the belt band, even with a constantly varying demand on its flexibility, can be avoided with certainty if the maximum demand likely to occur is kept so low that it does not attain the value of the limit of fracture.

According to the present method the breaking of the bands is avoided, and the durability made unlimited by the thickness; that is, the sectional dimensions which, when wrapping the pulley, is perpendicular to the pulley surface being arranged to be not more than a definite maximum.

The bands are made from carefully hardened and tempered carbon steel, prepared by special process, rough rolled at red heat and then brought down to standard thickness and width by cold working. The tensile strength of the finished material is about 95 tons to the square inch. The edges are rounded and so finely finished that the bands can be safely handled even when running at high velocity.

The dead weight of the steel band is very small, as compared with its great tensile strength, consequently, power for power, it is far lighter than any leather or woven-belt, than the equivalent power chains or cotton ropes.

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In the following table the approximate leading dimensions, namely, effective driving width and weight of leather belt, cotton ropes, power chain and steel band for a similar H. P. and transmission speed, are shown:

Approximate Weights and Driving Widths of Leather Belt, Cotton Ropes, Power Chain, and Steel Band for Transmitting 200 H. P. at About 3,000 Feet per Minute.

System	Weight per foot. Lbs.	Driving Width. Inches
Double leather belt	6	24
Five 2-in. ropes	7	15
Three-inch pitch chain	43	7
Steel band	15	8

It will be gathered from the preceding figures that the steel band is so light in weight that it would be impracticable to depend upon its sag to give any serious proportion of the driving tension or adhesion to the pulleys.

Owing to the high modulus of elasticity of steel it is very necessary to determine the length of a driving band with considerable accuracy; a short extension, compelled by cutting the band too short in the first instance, set up very serious stresses. To accomplish this purpose an ingenious device has been invented for determining the necessary length for the purpose of obtaining a truly correct working tension. For this purpose it is requisite to make allowance for the sagging of the band. This is effected in this manner: A measuring band of small breadth and of definite section is mounted onto the pulleys on which the operating band will subsequently be required to run, and the ends fitted into a tension frame. By means of a helical spring and calibrated nut, by the compression of which the arms of the tension frame approach one another, the total tension equaling the desired initial stress per square millimetre in the driving band, is read off on a scale provided for the purpose. One of the pulleys around which the band is placed (or also both pulleys in opposite directions) is now slowly rotated so that the friction of the pulley causes a rise in tension in that branch in which the tensioning apparatus is placed, without, however, the band being driven by the pulley. The tension indicated by the apparatus is noted, the pulley or pulleys are then rotated in the reverse direction, so that the concerned branch under test is now slackened to a certain extent; the tension then indicated by the apparatus is again read, and it is ascertained whether the arithmetical mean of the two tensions which has been read corresponds to the desired fundamental tension. The overlap of the ends of the measuring band are now cut off, and, the tension being released, the remaining length is the correct measurement to which the driving band unstrained must be cut.

The Joint.—Attention was next devoted to evolving a suitable method of connecting the ends of the bands together, and it was discovered that it is essential for insuring durability that the joint should be provided at its ends with extension surfaces of suitable curvature from which the steel band would be able to ride off on transition to the circular path around the pulley from the straight path. This led to the invention of the present joint, in which the clamping plates, being shaped to the pulley profile, stresses at the joint are distributed evenly over the whole width, and one of the most prolific causes of fracture in the early installations is thus avoided.

Friction Covering on Pulleys.—So that metal does not run to metal and to prevent any possible slip, a friction coating consisting of a layer of canvas, to which

is glued fine sheets of cork, is placed over the pulley rim, and to avoid stripping under variable load the pulley rim is first serrated by a rough file or chisel nuts. A special cement is available for use in very damp situations.

Co-efficient of Friction.—In a prolonged series of tests made to show the values of the co-efficient between a steel band and covered pulley it was found that for a useful tension, such as is now considered good practice in steel band driving, the frictional co-efficient between steel bands and covered pulleys is practically an equivalent value to that between leather belts and iron pulleys.

Stresses.—The permissible bending and tensile stresses for the normal use of steel bands depends on the total amount of the stresses, on the ratio of speed reduction, and on the ratio of the driving distance to the velocity of the bands. The bending stresses caused by running the belt over the pulley depend on the ratio of the band thickness to the pulley diameter. The tensile stresses thus determine the maximum bending stresses and the permissible thickness for the required pulley diameter. Where it is found impossible to obtain a width for a necessary tensile area by means of one band, several individual bands are run alongside each other. So as to allow the maximum power to be transmitted over a pulley of small diameter, it has been found necessary that the breadth of the band should be as large and the thickness as thin as possible.

Necessary Conditions.—The requirements necessary to the successful employment of steel band transmission are simple, but nevertheless important. The lack of even one of the essentials would lead to unsatisfactory results. On the other hand, given suitable conditions, the results are definite and certain. The shafts, bearings and fixings must be of a solid construction, strong enough to transmit the maximum load demanded. The shafts must also be parallel, and the pulleys running true.

Pulley Construction.—In steel band transmission it is necessary that the pulley face should be flat; that is owing to the fact that if the pulley was crowned the centres of gravity of the joint clip would be raised slightly from the pulley every time the clip would run on the latter, thus causing a blow to be struck which is greater the smaller the pulley diameter and the higher belt speed. The stress caused by this blow would be thrown mainly on to the middle of the band and this would cause gradual deterioration of the material at this point and ultimate fracture. As power for power, the steel band is only one-third the width of an equivalent leather belt, the use of specially narrow and correspondingly stronger pulleys enables considerable saving in weight to be made, particularly in large diameters, at the same time considerably reducing the cost.

Assuming from a millwright's point of view the shafts and bearings are properly proportioned and fixed, and the amount of power to be transmitted being already determined, the necessary calculations are then made for the size and length of the belt to be used. These are based upon carefully worked out formulae, and as the material is practically static (the maximum and minimum contraction and expansion being only 1-32 inch to the yard) the tension necessary for any particular power or width is exactly determined. Thus it will be readily understood that when once the belt has been mounted in the manner previously described it requires no further adjustment.

Advantages.—Assuming that the necessary conditions can be fulfilled, steel band transmission is guaranteed to give the following important advantages:

1. An efficiency in power delivery of 99.99½ per cent.
2. Great steadiness; a necessity for electrical machinery, textile purposes, paper mills, etc.
3. Favorable use of space.—The distances of pulleys are optional to a great extent, depending on the speed; a perpendicular drive is no disadvantage for Steel Band driving.
4. Absence of stretching.—A Steel Band does not stretch by use, as has been seen by eight years' experience.
5. Even running, free from slip.—As there is no actual measurable slip, it follows that transmission by Steel Bands is uniform and invariable.
6. Narrower width.—A Steel Band is only about one-third as broad as a corresponding leather belt.
7. Cool Bearings.—Owing to the exact calculations of the necessary tension for each particular drive, together with the great reduction in the weight of Steel Bands, there is a minimum of strain on the bearings, which consequently run cooler.
8. Cleanliness.—No dressings are required.
9. Unwearability.—Steel driving bands have now been in operation for eight years, and tests made of the belts first fitted show no signs of deterioration whatever.

In using the steel band in conveying the same general basic principles are adhered to as for transmission but other factors developed have also to be taken care of.

The steel band conveyor is designed in two ways:

(a) With the upper strand supported by rollers, i. e. rolling conveyor;
(b) With the upper strand sliding on timber runners, i. e. sliding conveyor.

In both cases the lower strand is supported by rollers at intervals of 15 to 30 feet.

Rolling Conveyor:

1. The upper strand of the band is supported by rollers at intervals of 6 feet to 13 feet according to the nature of the material conveyed.
2. For materials such as charcoal and coal, a box troughing arrangement can be employed, but in this case the distance between rollers is reduced considerably below that employed for the open belt.

Sliding Conveyor:—In many cases, particularly for short conveyors, and for certain classes of material, the upper strand of the steel band can slide on a timber support instead of being carried by rollers. With this type of construction the belt can run:

1. Free without trough.
2. In the bottom of the trough.
3. So that it forms the bottom of the trough narrower than the Steel Band and lined with steel plates.

The applicability of the rolling and sliding conveyor types depends on the nature of the material conveyed and on local circumstances. A combination of the two methods can also be employed. The framework is made either of wood or metal. As a general practice the terminal pulleys are of cast iron of 40 inches diameter. The bearings of the terminal pulleys are designed so as to enable an easy adjustment to be made.

The only variations in length of the band to be taken into consideration are those due to changes in temperature. For short conveyors the tension of the band is adjusted by means of movable bearings of the driven terminal pulley. For long conveyors, 130 feet or more, as well as for conveyors handling warm material, the driven terminal pulley is fitted on a tension frame supplied with counterweight or steel springs to obtain the necessary stretching force.

Conveyor.—The joint of the steel band is made by means of single row riveting with the rivets countersunk and short overlap. The rivet holes are punched with a special punching tool through both ends of the band at the same time. Due to the rivets being countersunk they remain firm after the heads have been worn away. The bearings for the supporting rollers are carried on pillow blocks easily movable horizontally so as to facilitate erection and adjustment.

Running of the Band:—The true running of the steel band depends mainly upon the accurate location of the end pulleys and supporting rollers. These should be exactly in line with each other, the shafts being at right angles to the direction of motion of the band. As an additional precaution, long conveyors are supplied with flanged idlers at intervals of about 65 feet on the upper strand, and 100 feet on the lower strand. With terminal pulleys of 40 inches diameter, the distance between the upper and lower strand at the guide roller is about 2 ft. 6 in.

The Feed:—The material conveyed is fed on to the belt with the usual hopper or chute arrangement, and need not be fed in a longitudinal direction, though this, of course, is always advantageous in order to get material to rest quickly and quietly on the band.

Discharging:—The material is delivered from the band either over the end pulley or by means of delivery scrapers. These are constructed of laminated steel plates and designed so that they can easily be removed from one point to another.

The drive of the steel band generally consists of spur gears. The driving gear can be placed either at the charging or discharging end.

The characteristics of the steel band permit the following advantageous applications of the conveyor not hitherto possible:

1. If the material conveyed is to be discharged at a point of the conveyor other than the end pulley, the expensive and power consuming throw-off carriages are replaced by a simple delivery scraper or plow.
2. By means of delivery scrapers of special construction medium sized material can be discharged at several points at the same time.
3. The material to be conveyed need not, as previously mentioned, necessarily be delivered on to the band in a direction parallel to that in which it is running.
4. Sticky materials such as sugar, clay, etc., can be discharged easily and perfectly and the band kept clean without any difficulty whatever.
5. Sharp-edged and cutting materials, such as broken glass, can be handled satisfactorily.
6. In special cases supporting rollers may be dispensed with and the loaded strand drawn directly over a timber runner without unduly wearing the steel band. Under the action of the steel the timber runner becomes highly polished and the power consumption due to friction is relatively small.
7. Owing to its rigidity in a transverse direction, the steel band has a larger conveying capacity than textile bands. The edges of the band do not bend down even with considerable load obliquely discharged.
8. The supporting rollers can be made narrower than the band thus permitting, at reasonable cost, the use of large diameters for the idlers with correspondingly low power consumption.
9. Low elongation permits considerable distances between the idlers for the loaded as well as for the empty strand of the band without excessive local sagging.
10. Insensibility to moisture and variation of temperature permit the use of the steel band conveyor in the open air, though in certain cases it is advisable to give the band a coating of tar or oil.
11. Hot material up to a temperature of 212 degrees Fahrenheit can be handled safely by the steel band.